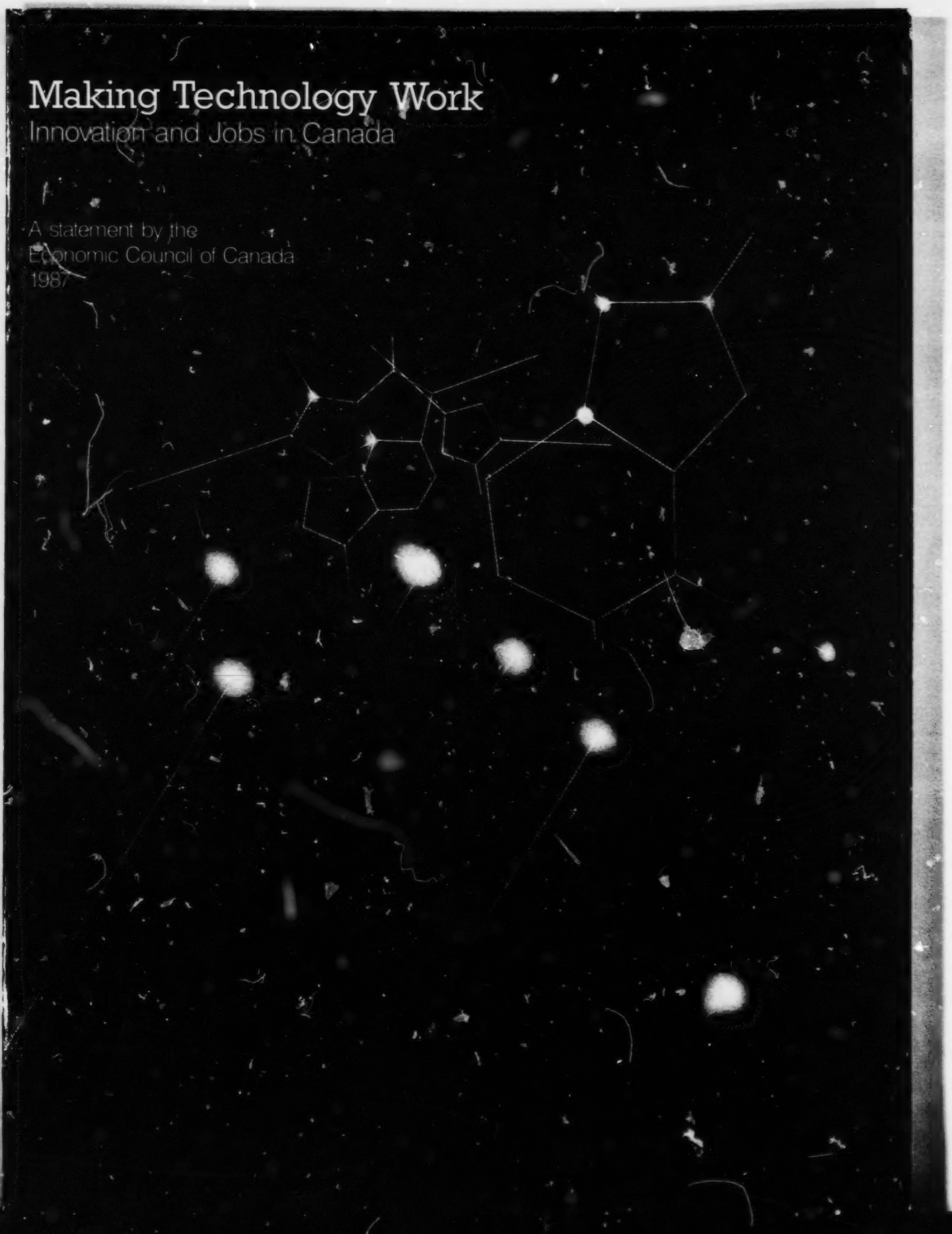
Making Technology Work

Innovation and Jobs in Canada

A statement by the
Economic Council of Canada
1987



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Foreword

Technological change is a crucial means to economic advancement. It is the key to improvements in productivity, global competitiveness, and, ultimately, employment. Rapid adoption of new technologies is therefore vitally important to future prosperity. The Council first drew attention to Canada's poor record of technological advance in *The Bottom Line*, published in 1983. Since then, the pace of technological change has accelerated, and many Canadians have embraced the new technologies, some happily, some involuntarily. Yet, Canada still lags behind its trading partners, and now, with unemployment at frustratingly high rates, there is genuine concern about how the new technologies will affect people and jobs. (Employment and unemployment have been of vital interest to the Council throughout its history.)

This study marks a convergence of two important areas of economic research. Technological change has thrown traditional labour market adjustment problems into sharper focus. Where will jobs be created, where will they be lost? How do individuals prepare for them? How must organizations adjust? Do social institutions need to change? This study of the impact of technological change on the labour market is unparalleled in its scope and depth of coverage. It involved not only imaginative use of existing national data sets (including projections to 1995) but also a special survey of 1,000 Canadian establishments and detailed study of a handful of innovating organizations. It is designed to contribute to the important policy debate as to how adjustment to rapid technological change can be achieved both equitably and efficiently.

This short Statement by the Council's members summarizes the principal research findings, highlights policy issues, and sets out, in the last section, a strategic policy framework. It is, in essence, a synthesis of the more detailed findings published in a companion volume entitled *Innovation and Jobs in Canada*.

The policy framework we set out is designed to emphasize the importance and mutual dependence of rapid advances not only in technology but also in the development of human resources. We advance a number of broad policy objectives and offer more specific, constructive suggestions to help Canadians to maximize the payoffs from technology.

On behalf of the Council, I would like to thank the Advisory Committee, composed of four Council members and three outside experts who together represented business, labour, and the high-tech community. Under the Chairmanship of Kalmen Kaplansky, the Committee gave valuable guidance to the research team and helpful advice on the policy discussion.

A special note of thanks is due to Diane Bellemare, whose term on Council expired in March, before the sign-off date for the report. Her rich experience in labour market issues provided valuable input to the Council's deliberations.

Judith Maxwell
Chairman

Making Technology Work

READER'S NOTE

In this Statement, details in the tables and figures may not add up to totals because of rounding.

1 An Overview

Material progress over the course of history has been identified through the landmarks of technology. We have moved from the Stone Age, through the Bronze and Iron Ages, to the Industrial Age; some say we have now entered the Post-Industrial Age. Transition from one epoch to the next has, in each case, been destabilizing: while change offers new opportunities, it poses threats to the status quo, and inevitably it alters the balance of economic power among countries and among groups within a society.

The current wave of innovations includes biotechnology, laser technology, new materials, sensor technologies, and others. (A nontechnical description of some of the new technologies can be found in *Workable Futures*, prepared in 1986 for the Economic Council by Words Associated and Keith Newton.) The most visible of these innovations, because of its direct impact on almost everyone, is microelectronics, which grew out of the development of the transistor in the late 1940s and of progress in the miniaturization of computer components in the 1970s. As microelectronics becomes more pervasive, employers and workers are being forced to alter the way work is performed. Eventually, this technology will make an imprint on the whole pattern of social relationships associated with the workplace. Thus it is no exaggeration to put the microelectronics revolution in the same league, from the point of view of human development, as the Industrial Revolution. Indeed, we often refer now to the evolving "Information Economy."

Many Canadians have welcomed the new technologies as a source of fun, efficiency, and intellectual development. But many others share misgivings about what effect these innovations will have on their jobs and their incomes. Do the new technologies create or destroy jobs? Where will the new jobs be? Which occupations are threatened? Is Canada adopting the new technologies fast enough? Will certain groups fare less well than others? These are some of the general questions posed by the Economic Council in its study of the impact of the new technologies on the labour market. In doing so, we have looked at the impact on the workplace, on individuals, on firms, on unions, and on government programs.

Our study has been comprehensive. We have surveyed about 1,000 establishments across Canada; we have examined existing data sets in detail; we have made projections of the possible future impact of technology; and we have undertaken a series of case studies that add richness and colour to our understanding of what is happening in the workplace.

The task that faces Canadians is to make technology work to their advantage. Canada has numerous examples of firms that are at the leading edge in adopting technology and using it effectively. The problem is that many Canadian organizations – in the private as well as the public sector – lag far behind in this respect. The success stories show that Canadians can do it, but too many managers, employees, educators, and policy makers in this country are not yet on track. Such complacency costs Canadians jobs and incomes as other countries increase their lead.

* * * * *

The detailed results of our research are contained in a companion volume to the present Statement, entitled *Innovation and Jobs in Canada*. The Statement by the Council provides an overview of those research results, as well as an outline of the strategic policy framework proposed by the Council. It also describes the great challenge ahead if Canadian society is to ride the technological wave towards greater prosperity. Our overview of the research is divided into five sections.

In the first of these (Section 2), which deals with innovation in Canada, we identify the technologies that have been introduced and the kinds of firms that innovate. We ask why they innovate, and we assess Canada's innovation performance in an international perspective.

In Section 3, on employment and income, we ask what happens to Canadian jobs and earnings as the new technologies are implemented. What types of jobs are likely to be available in the future? Which ones will tend to disappear? Is there any evidence that the proportion of middle-class workers in Canada has declined?

Section 4 deals with the management of innovation. In order to exploit the full potential of the new technologies, organizations have to change. They must become less rigid and hierarchical, and they must embrace policies and procedures that will involve both management and employees in problem-solving.

In Section 5, we ask the question: Can the Canadian industrial relations system adequately meet the challenge of the new technologies? Particular attention is paid to how well collective agreements handle such concerns as advance-notice, job-security, and retraining provisions.

Section 6 contains our results on the way the new technologies are likely to affect women and other groups in the labour market, such as young people, older workers, and disabled people.

Finally, in Section 7 we put forward the key elements of a national strategy to help Canadians reap the benefits of wealth and job creation that flow from the new technologies. The two major arguments of the final section of this Statement are: first, Canada must rapidly adopt the new technologies in order to maintain and enhance productivity, quality, competitiveness, and employment; second, Canadians must simultaneously erect the strategic policy framework that will encourage the necessary adjustments while minimizing their costs. The two points are interdependent: without rapid technological advance, we stand to lose competitiveness and jobs; without a secure, flexible, and highly skilled work force, we face slower technological advance.

2 Innovation in Canada

While a number of studies have been done on technological change, there exists no comprehensive assessment of where Canada stands with respect to the use of the new technologies. To fill that gap, in late 1985, the Council conducted the Working with Technology Survey (WWTS), the results of which are summarized in a 1986 publication, *Working with Technology: A Survey of Automation in Canada*, prepared for the Council by Gordon Betcherman and Kathryn McMullen.The WWTS focused on the computer-based technologies, for three reasons. First, in the short and medium term, these technologies are expected to have the most wide-ranging impact on work, since they have applications in all industries and affect a large variety of jobs. Second, the computer-based technologies have evolved rapidly, are highly visible, and have diffused widely. As a result, it is relatively easy to identify the users of these technologies and thus to determine how firms and other organizations have adjusted to them. Third, computer-based technological change is important in its own right. Many consider it to be an "enabling" technology, a tool that permits rapid change in other fields.

The WWTS has enabled us to determine how widely the computer-based technologies have diffused in Canadian industry and how firms are responding to them. Not only is it the first survey of its kind in Canada, but by including businesses of all sizes in nearly all industries (agriculture, fishing, construction, and public administration were excluded) and in all regions, its results are more comprehensive than those of any other survey available from other countries. Responses were received from close to 1,000 establishments, both Canadian- and foreign-controlled. The survey results on computer-based innovation in Canada in the period 1980-85 are summarized in this section. A fuller discussion is found in Chapter 6 of our research report.

The WWTS results show that while Canadian industry has introduced much computer-based technology in the 1980s, this country is lagging in comparison with other industrial nations, particularly Japan, the United States, and Western Europe. Our message, therefore, is that Canadians must improve their performance with respect to the introduction and use of the computer-based technologies. Failure to do so will lead to a loss of prosperity and jobs as Canada's competitive position deteriorates.

The Technologies

The first half of the 1980s can best be described as a period during which office automation was the dominant feature of computer-based technological change. Overall, 64 per cent of the innovations introduced between 1980 and 1985 fell into that category (Figure 1). New office technologies were dominant in all sectors, including manufacturing and the resource industries, as well as in the more information-oriented service industries. Process-automation technologies accounted for another 23 per cent of all innovations adopted between 1980 and 1985, while the remainder (13 per cent) consisted primarily of specialized computer applications in a few industries. Within the manufacturing sector, with which process automation is most usually associated, new process technologies accounted for 37 per cent of the reported applications of computer-based technologies. The primary

Figure 1

Computer-based technologies introduced in Canadian organizations between 1980 and 1985

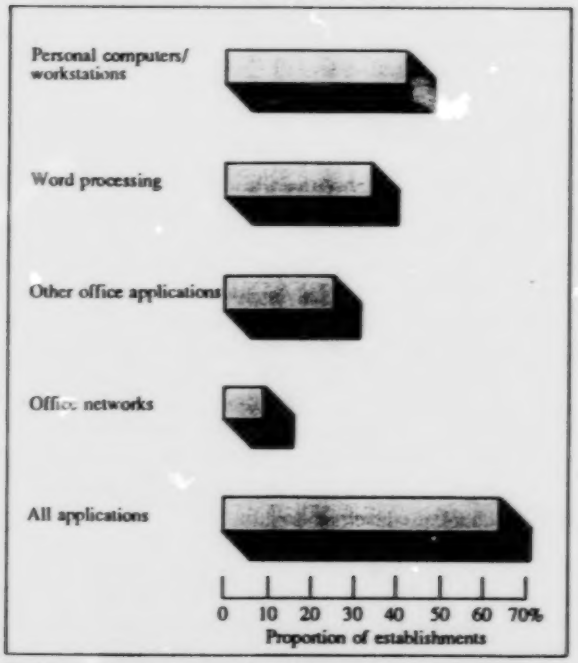
Based on G. Betcherman and K. McMullen, *Working with Technology: A Survey of Automation in Canada*, Economic Council of Canada, 1986.

reason for the introduction of office automation was to increase productivity, while the use of process automation was prompted by a wider variety of reasons. Productivity growth was of central concern here as well, but the desire to improve product quality, to reduce labour costs, and to increase control over production was also a frequently cited motivation.

In terms of the scale of change, office-automation technologies were introduced in the 1980-85 period by 65 per cent of all the establishments surveyed. Personal computers/workstations were the most common application, followed by word processors and computers used for general office applications, such as payroll, accounting, and sales analysis (Figure 2). For the most part, office automation consisted of "stand-alone" systems where, arguably, the impact was confined to individuals and small groups of workers. The next major phase of office automation, which actually began during the first half of the 1980s, will be larger-scale, more sophisticated, integrated networks; 9 per cent of the establishments surveyed in 1985 reported that they had introduced such office networks. The results of an independent survey reported on by the Evans Research Corporation that year confirms this trend towards integrated networks.

Figure 2

Office automation: scale of adoption by Canadian establishments between 1980 and 1985



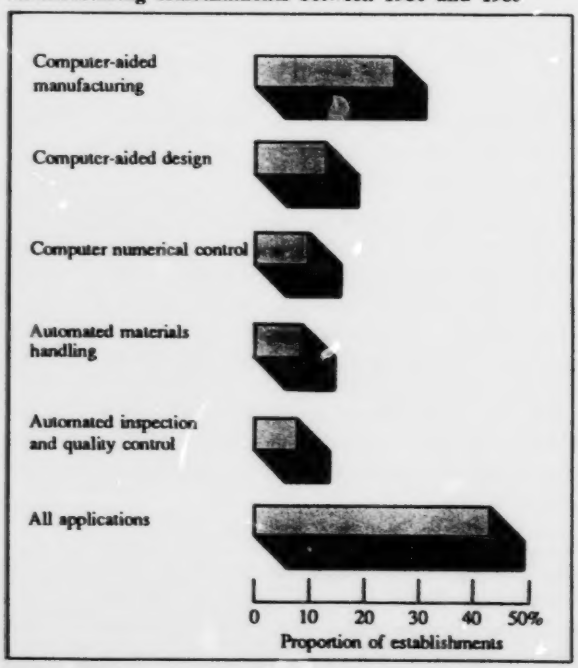
Based on the Economic Council of Canada's Working with Technology Survey.

Computer-based process technologies, on the other hand, diffused less widely between 1980 and 1985. While their scale of penetration was not insignificant, they cannot be said to have become pervasive. Overall, 43 per cent of manufacturers reported the introduction of some type of process automation (Figure 3). Computer-aided manufacturing (CAM) achieved the highest level of penetration, with 26 per cent of establishments reporting innovations of this type. Fewer than 15 per cent of manufacturers, however, introduced the other process technologies – computer-aided design (CAD), automated materials handling, computer numerical control (CNC), and automated inspection and quality control – elements of each of which are necessary for full factory automation. The highest penetration levels were evident in the machinery, chemicals, and electrical and electronics industries. The expected trend in the period 1986-90, however, is towards increasing rates of diffusion of computer-based process technologies. We can therefore expect, in the near future, increased sophistication in the use of computer-based technologies both on the shop floor and in the office.

The predominance of office over process technologies in the first half of the 1980s can be explained in part by

Figure 3

Process automation: scale of adoption by Canadian manufacturing establishments between 1980 and 1985



Based on WWTS.

differences in the relative cost of the technologies and in the degree of difficulty encountered during their implementation. Compared with process automation, office technologies tend to require low levels of investment. For example, the median levels of expenditure on personal computers/workstations and on word processors were $25,000 and $20,000, respectively. In contrast, the medians for CAD, CAM, and CNC machines were $100,000, $200,000, and $400,000, respectively. Also, the office technologies can be introduced on a smaller scale, with compartmentalized effects. On the other hand, process automation and the more sophisticated office networks tend to affect whole systems and sets of workers; as a consequence, they bring more complications.

The Innovators

Overall, 75 per cent of the respondents to the survey reported that they had introduced some type of computer-based technology between 1980 and 1985. When reported plans to 1990 are taken into account, we find that fully 85 per cent of respondents will have had direct experience with computer-based technological change during the current decade.

Who are the innovators? One simple method for identifying them is to include all those respondents who reported the introduction of any computer-based technology. This measure does not, however, take account of differences among innovators with respect to how much computer technology they are using. Accordingly, we developed two measures of "technological intensity." The first consists of the ratio of employees actually working with computer technology in 1985 to all employees, in each establishment. The second is the ratio of expenditures on computer-based technology to total sales over the period, again for each establishment.

As to regional differences in innovativeness, we find that the Prairie provinces and British Columbia ranked highest with respect to the proportions of establishments reporting any computer-based technological change during the period 1980-85 and of employees working with computer-based technologies in 1985. Ontario and Quebec ranked highest, however, when the measure based on the expenditures/sales ratio is used. This reflects the higher-cost structure of process automation that is characteristic of manufacturing, which, in turn, is concentrated in those two provinces.

Four industries ranked high with respect to two of our measures of innovativeness: communications and other utilities; wholesale trade; finance, insurance and real estate; and business services. The retail industry also ranked high in terms of the percentage of employees working with computer-based technologies in 1985. In manufacturing, the four highest-ranking industries on at least two of the measures of innovativeness were printing and publishing; machinery; chemicals; and electrical and electronics products. Three industries, on the other hand, scored very low on all three measures: leather, textiles, and clothing; wood and furniture; and primary metals.

Larger establishments were more likely than smaller ones to have introduced computer-based technologies. That is not surprising, given the wider range of opportunities open to larger establishments. However, the intensity of use of computer-based technologies tended to be no greater in larger than in smaller establishments; there was very little difference between the two with respect to the percentage of employees working with the new technologies and to the computer expenditures/sales ratios characteristic of each group.

The question of the impact of foreign control on Canada's economic performance has long been a contentious issue in this country. Echoing the Council's conclusions in a previous report (*The Bottom Line: Technology, Trade, and Income Growth*, published in 1983), the WWTS results indicate that while the R&D/sales ratios of foreign-controlled firms are lower than those of domestically controlled firms, their performance with respect to innovativeness tends to be stronger. Foreign firms operating in Canada were more likely to have introduced computer-based technologies in the period 1980-85 and tended to have a larger proportion of employees working with the new technologies; in the case of U.S.-controlled firms, they also had higher computer expenditures/sales ratios.

An International Comparison

Despite this evidence that the introduction of computer-based technologies appears to have reached a relatively high level in Canada during the first half of the 1980s, the general perception in this country is that, overall, Canada lags behind a number of other Western industrialized nations in the development and use of new technologies. Indeed, the Council showed in *The Bottom Line* that Canada tends to be slow when it comes to the introduction of new technologies. While recent evidence suggests that Canada's competitive position has improved somewhat relative to the other OECD countries, problems with productivity growth, capital investment, and technology development are still highlighted.

The usefulness of international data on the level of use of computer-based technologies is limited in that both the definitions of technologies and the years reported on tend to vary. No country, including Canada, yet has regular surveys on the subject conducted by official statistical

agencies. These difficulties notwithstanding, we have attempted to assess the evidence that is available.

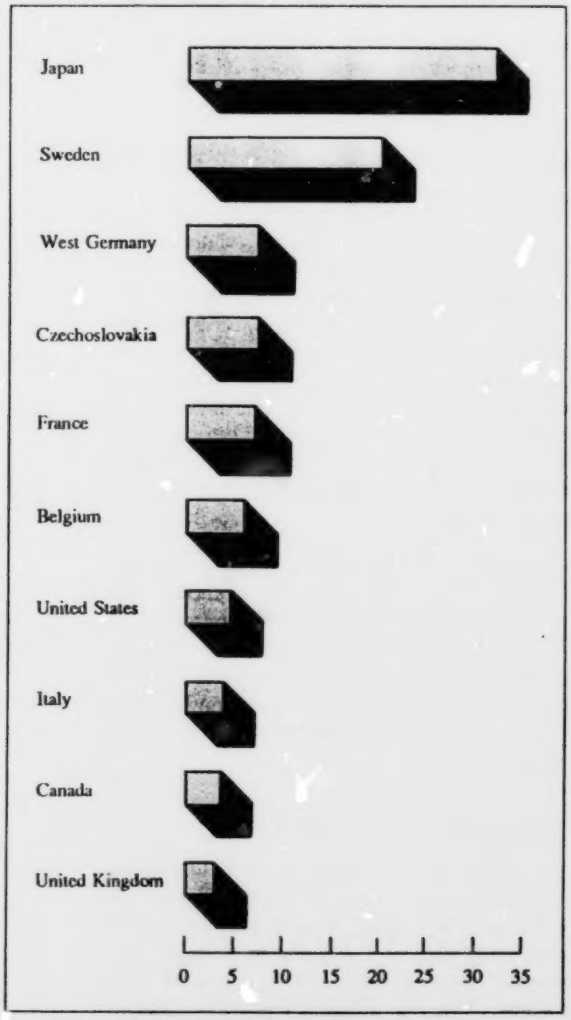
The first set of international data pertains to the level of use of robots and numerically controlled (NC) machine tools. In 1984, Canada ranked ninth out of ten countries in the number of robots used per 10,000 workers employed in manufacturing – well behind Japan and Sweden, in particular (Figure 4). Another estimate (by the Evans Research Corporation) places Canada three to four years behind the United States in the rate of adoption of robot technology. With respect to NC machine tools in use as a proportion of all machine tools, Canada, with 4.4 per cent in 1983, ranked well behind Japan (38.1 per cent), the United States (12.9 per cent), and the United Kingdom (8.1 per cent).

The second set of data comes from two surveys conducted in Japan, which provide data that are roughly comparable to our own survey data. For the two technologies that can be compared – automated inspection and quality control, and automated materials-handling equipment – the adoption levels in Canada between 1980 and 1985 were much lower than those achieved in Japan by 1982. Overall, 60 per cent of Japanese manufacturing establishments employing 100 or more workers were using some type of microelectronics equipment in 1982. A similar level (58 per cent) was reached in Canada in 1985.

A third set of data suggests that a substantial Canadian lag is also apparent when comparison is made with three European countries. The levels of adoption of microelectronics technologies in process applications were higher in West Germany, Britain, and France in 1983 than they were in Canada in 1985 (Figure 5). Our research suggests that the Canadian/European gap can be attributed mainly to much lower adoption levels among medium-

Figure 4

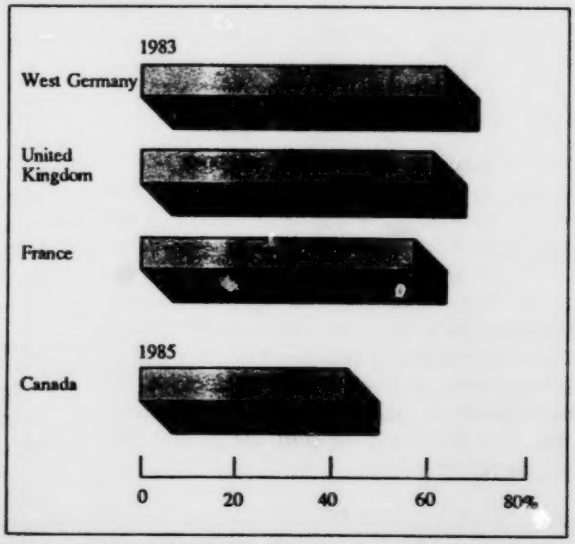
Number of robots per 10,000 persons employed in manufacturing, selected countries, 198- (January 1)



Based on Ontario Ministry of Industry, Trade and Technology, *Flexible Automation Equipment*, Toronto, 1985.

Figure 5

Proportion of manufacturing establishments using microelectronics in processes, selected countries, 1983 and 1985



Based on J. Northcott (with P. Rogers), *Microelectronics in Industry*, Policy Studies Institute, London, 1985, and on WWTS.

sized, Canadian-controlled establishments and among the largest establishments, both Canadian- and foreign-controlled.

Canada's Strengths and Weaknesses

At the same time, it should be recognized that Canada does have some notable technological strengths. Examples are found in telecommunications, large-scale engineering, agriculture, and forestry. And many manufacturers have some quite sophisticated microelectronics systems in place. The problem is not with the few advanced industries and firms, but with the majority of producers who are slow to adopt innovative practices.

Canada's persistent lag in the introduction and use of computer-based technologies is an urgent national problem of major proportions. The diffusion of process technologies is too slow. The capital investment needed for the introduction of advanced equipment is also lagging seriously. Without that spending, process automation just cannot take place.

Of even greater concern is what lies behind a superficial counting of machines. Ultimately, it is not so much a question of how many machines are on the shop floor, but how effectively they are used. While the United States ranks well ahead of Canada in the amount of process automation equipment per worker, it is substantially behind Japan in the level of use of CNC machine tools. As well, the United States is much less effective than Japan in the management of microelectronics technology, according to a recent study. The simple addition of a new piece of computer-based equipment on a production line, without adequate training of employees to exploit its fullest potential, results in few, if any, gains in quality and in efficiency of output. Yet, that is what is happening here and, according to many observers, in the United States as well.

Japan, on the other hand, has been working – with notable success – to create a new national "mind-set" that is based on the integration of microelectronics with the whole of the production system. Workers are highly trained and, in fact, are often involved in the design and implementation of the systems. The equipment is not something foreign that is superimposed onto a traditional way of doing things; rather, it becomes a familiar tool in a new and better way of doing things. As a result, the gains being realized in Japan (and in some European countries that have also made the shift) are greater than they are in Canada.

* * * * *

What this means, ultimately, is that the gap is much larger and more serious than first appears. The effective use of the new technologies is part of a learning process. Countries that are ahead of Canada in terms of numbers of machines are also further along the learning curve. Any delays will make catching up even more difficult. The stakes are high and getting higher, and Canada must act now. Failure to do so would mean a deterioration in Canada's competitive position relative to its major trading partners. Adjustment would still take place, but it would be negative adjustment, involving lost jobs and decreased incomes.

The challenge, therefore, is for all Canadians to embrace technological change openly and for Canada to improve its innovation performance relative to its major trading partners. More firms in this country must follow the steps of those Canadian companies which are world leaders in advanced technology. This requires a fuller comprehension of both the technical and human aspects of the new technologies, so that the potential they offer can be exploited effectively and equitably.

3 The Impact on Employment and Income

What – and how much – Canadians produce, how much they are paid, and what they consume are all affected profoundly by technological change. One of the primary focuses of our research has been, therefore, the impact of technological change on total employment, on the structure of employment, and on the distribution of income, as well as on the output, cost, and productivity performance of the high-tech sector. Ultimately, the competitiveness of Canadian business and the growth in living standards depend critically on the ability to use technology.

At the same time, technological change is not the sole factor shaping the face of the Canadian economy. We have therefore devoted a great deal of effort to the task of disentangling the effects of technological change from those other effects. We have also considered possible future employment effects with an imaginative new model that incorporates the impact of computer-based technological change.

Canadian Employment Change, 1971-81

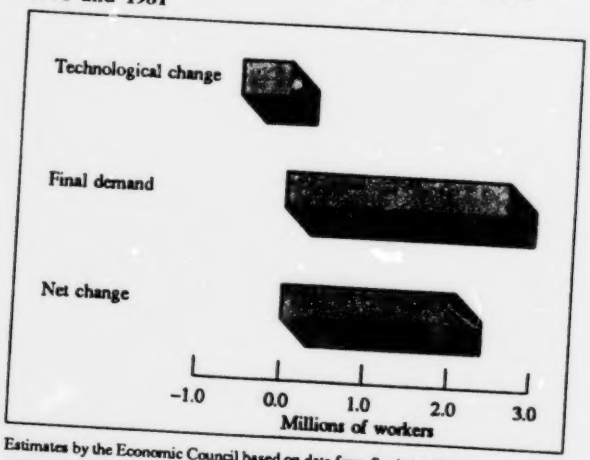
In order to determine the impact of technological change on employment, one must, first, identify what has taken place historically; second, armed with this understanding, one must project the sorts of changes that might be expected for the future. In this section, which is based on Chapter 3 of our research report, we analyse recent employment changes arising out of shifts in the industrial and occupational structure of employment,

identifying the role played by technological change in those shifts.

Changes in the structure of employment can be attributed to changes in demand and to changes in technology. The latter are reflected in changes in productivity and in the amounts of the various goods and services that are combined to produce output. When the 39 industries that make up the Canadian business sector are examined for the period 1971-81, we find that the single most important source of employment growth was growth in the economy as a whole (Figure 6). Growth in demand was sufficient – and usually more than sufficient – to offset any negative employment impact arising out of technological change.

Figure 6

Sources of change in Canadian employment between 1971 and 1981



Estimates by the Economic Council based on data from Statistics Canada.

There are three major sources of differences in employment growth patterns between industries. The first consists of changes in what we consume – i.e., in final demand. Through time, tastes change. For example, eating in restaurants has grown in popularity in recent years, and fewer meals are consumed at home. As a result, the accommodation and food services industry has grown in size.

The second source of difference consists of changes in productivity. In some industries, the use of new technologies and new management techniques has led to a decline in the amount of labour required to produce a given amount of output. Such was the case for agriculture in the period under review, when employment decreased in that sector. In other industries, such as retail trade, productivity did not grow; as a result, the impact of this factor on retail employment was positive.

The third source of differences in employment growth between industries is related to changes in the mix of the various goods and services that are combined to produce an output. Such changes in the production "recipe" occur, for example, when automobile manufacturing uses more plastic and fewer steel parts, or when several mechanical components in a telephone are replaced with a single microchip. In the first case, the size of the steel industry tends to be reduced while the plastics industry tends to grow. Similarly, in the second case, the parts industry tends to become smaller while the electronics industry tends to increase in size.

During the 1970s, changes in the composition of final demand acted to decrease employment in most of the goods-producing industries and to increase employment in most of the service industries. Overall, the net impact of this factor on employment in the economy as a whole was to cause a small decrease.

The impact of the second factor, productivity growth, varied across industries. Most industries did, in fact, experience productivity growth between 1971 and 1981. Consequently, employment levels were lower than if that productivity growth had not taken place. That is exactly what would be expected, since labour productivity growth is defined as a reduction in the amount of labour required to produce a given amount of output. Without productivity growth, the ability of industries to compete is impaired; in the long run, employment losses are substantial, as inefficient firms are forced to close.

The third factor – changes in the amounts of goods and services that are combined to produce output – also had a range of effects. Some industries, such as agriculture, saw the demand for their products decrease during the period. Others, notably communications and services to business management, found that business demand for their output increased. Overall, this factor resulted in a small increase in total employment. Taken in isolation, it would appear that productivity growth acted to decrease employment by 10 per cent between 1971 and 1981. The various sources of employment growth and decline do not act in isolation, however. Productivity growth has two effects. On the one hand, as efficiency improves, the amount of labour required to produce a single unit of output decreases. On the other hand, improved efficiency has a positive impact on incomes, reflected partly in higher earnings for workers and partly in higher profits for producers. Higher incomes lead to growth in demand, while higher profits mean that producers have the capital to invest in order to meet the higher levels of demand. Workers, of course, are needed to produce those higher levels of output; and, as a result, the number of jobs grows.

We refer to this chain of events, in which the productivity improvements resulting from the new technologies translate into increased employment, as the "productivity payoff." In fact, growth in final demand, between 1971 and 1981, did cause employment to grow substantially, more than offsetting any negative impact of productivity growth. In other words, the positive effect of productivity growth on incomes was substantially larger than its negative impact on employment. The net result was that total employment grew 30 per cent over the decade.

The Canadian business sector is made up of 85 different occupational groups. Any one occupation – that of managers, for example – is spread across different industries. And any one industry is made up of a number of different occupations – for example, managers, professional/technical staff, skilled and semi-skilled workers, and sales and clerical staff. Therefore, changes in the occupational structure of employment stem from changes in both the relative size of each industry and the occupational structure within each industry – that is, changes in staffing patterns. Between 1971 and 1981, high-tech occupations (engineers, systems analysts, computer programmers, and so on) experienced high rates of employment growth as a result of increases in the demand for those skills. Low-skill occupations (such as general office clerks, mining workers, labourers in construction, and barbers and other personal service workers) saw the demand for their skills diminish.

Just as in the case of employment by industry, the impact of technological change on occupational employment is twofold. First, employment is affected directly as technological change acts to increase efficiency and decrease the amount of labour required. Second, the "productivity payoff" causes incomes, demand, and output to increase. The net effect during the period 1971-81 was employment growth in the vast majority of occupations; the only decreases occurred in the cases of general office clerks, farmers, nursery and other farming occupations, textile processing occupations, "other" metal machining, labouring in construction, and "miscellaneous" occupations.

If we look only at the direct employment effects of technological change, we find that growth occurred in 43 per cent of all occupations, employing 36 per cent of all workers. And some wholly new occupational classifications have appeared, such as computer-aided design draughtspersons (replacing traditional draughtspersons), videotex page designers, clinical immunologists, word-processor operators (replacing typists), fibre-optic cable splicers, and nuclear technologists. Some of these occupations are completely new, while others (word-processor operators, for example) employ more or less the same people as before but under a new occupational name to reflect new skills and new tools. And some occupational classifications have disappeared altogether – hand washers, starchers, elevator starters, switch repairmen (rail), and riveters (pneumatic), for example.

The Performance of the High-Tech Sector

Our analysis shows that technological change does, indeed, have a wide-ranging impact on the structures of industry and occupations. But in order to get a clear picture of the role of technological change in economic growth, one must go one step further and analyse how well the users of high technology perform compared with non-users, both in terms of rates of employment and output growth and in terms of cost effectiveness. The results of this analysis are presented in Chapter 2 of our research report.

First, we examined the existing definitions of high technology and found that they were inadequate for our purposes, since they tend to focus only on producers of high-tech goods. Accordingly, we developed a broader definition of the high-tech sector, to include not only the producers but also the users of high technology, for it is only in the application that any real impact will be felt.

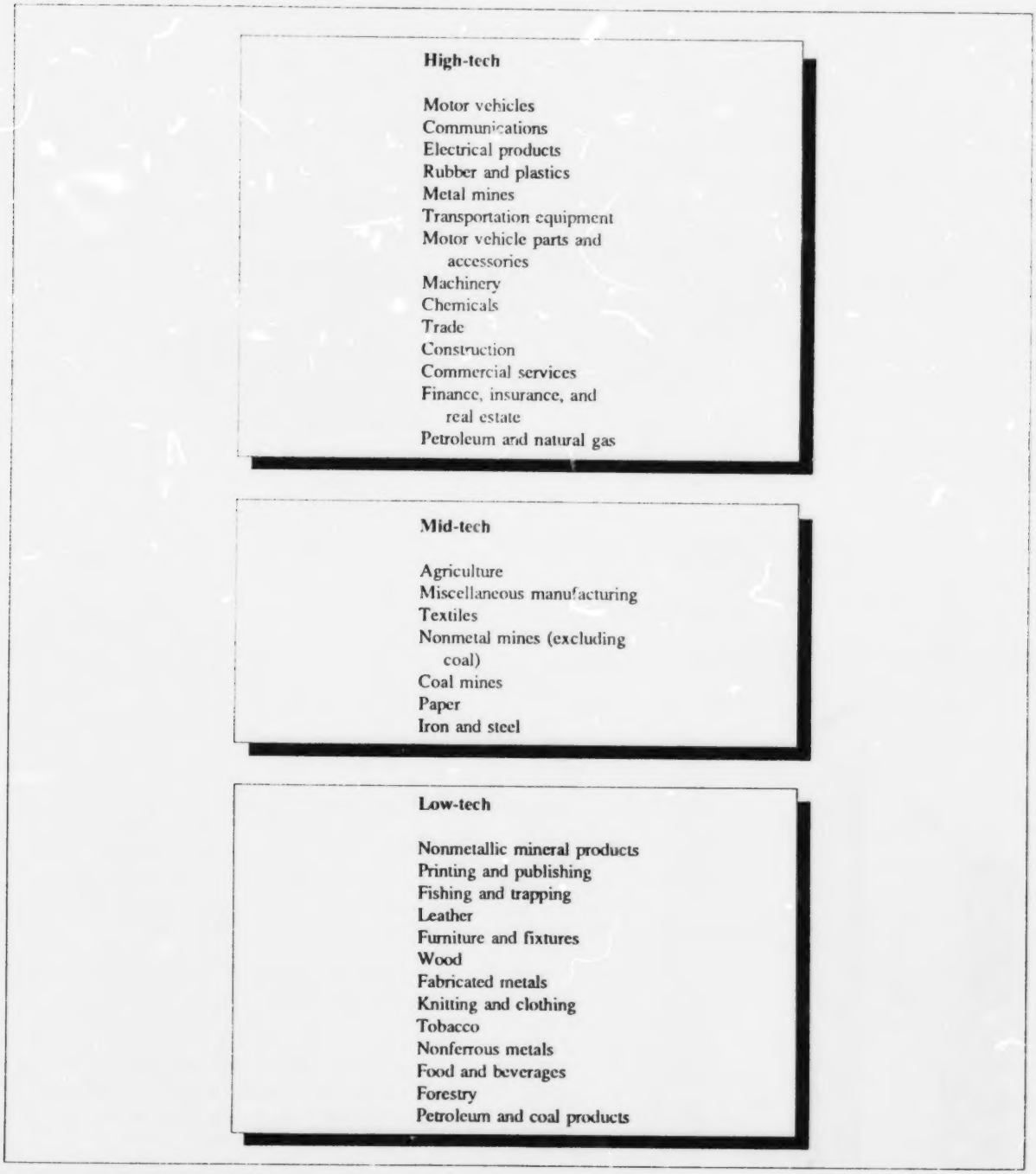
In order to make a good or provide a service, businesses purchase materials and services – known as intermediate inputs – from other businesses. Some of these inputs are relatively unsophisticated (wood, for example), while others (such as electronic components) are highly advanced. And the extent to which industries use sophisticated – or high-tech – inputs varies. Our definition of high technology is therefore based on the proportion of all intermediate inputs that is made up of high-tech inputs. Depending on how well an industry scored with respect to this high-tech ratio, it was classified into one of three groups: high-, mid-, or low-tech.

In Figure 7, the major industry groups are shown according to their technological status. Among the high-tech industries are communications; finance, insurance, and real estate; machinery; and electrical and electronic products. Also included is trade, reflecting the fact that both wholesaling and retailing have undergone a tremendous amount of technological change in recent years. Automated materials handling and automated warehouses are increasingly common, and the electronic cash register has diffused widely. Many sales clerks are now routinely using computers that are connected to automated inventory systems and to automated credit checks.

Overall, the high-tech sector experienced higher rates of employment and output growth throughout the 1970s and

Figure 7

Industry ranking by technological status,[1] Canada, 1980



1 The ranking was determined by estimating the value of high-tech inputs as a proportion of all nonlabour inputs at the three-digit level of industry classification (comprising 191 industries). The industries were then ranked in decreasing order of high-tech input values and divided into three equal groups – high-tech, mid-tech, and low-tech. For the purposes of this figure, the 191 industries have been regrouped into broader categories.

Estimates by the Economic Council based on data from Statistics Canada.

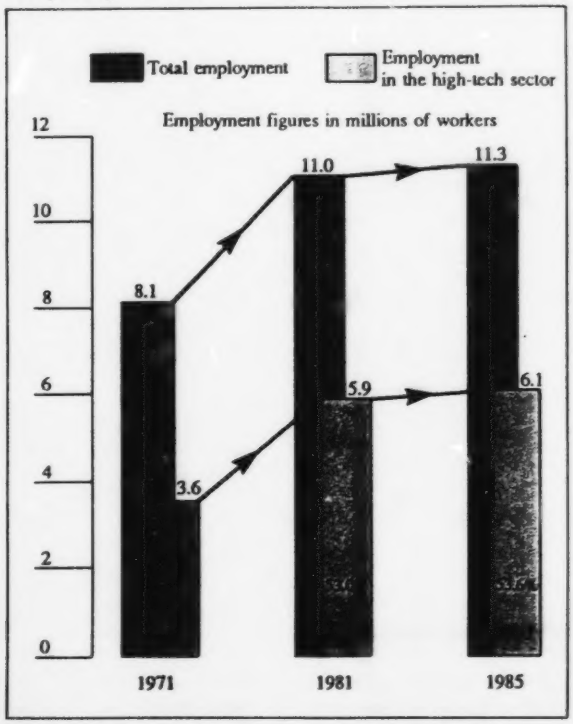
the early 1980s than did the mid- and low-tech sectors. In most cases, the rate of output growth was sufficiently high to offset the negative impact of productivity growth on employment, with the result that employment in this sector grew as a proportion of all employment (Figure 8). Nevertheless, in a few high-tech industries (notably the electrical products and automotive industries), output in the period 1981-85 failed to grow at rates sufficient to offset the negative impact of productivity growth, with the result that recent employment growth in these industries has been negligible.

In terms of other indicators, we also found that the high-tech sector has performed better than the mid- or low-tech sectors. While all three sectors have been affected by similar sources of increase in the costs of production – mainly rising labour and material costs – the high-tech sector turned in the best performance with respect to the efficiency with which the inputs have been combined in the production process.

Evidence from the Working with Technology Survey also provides support for the contention that, on balance,

Figure 8

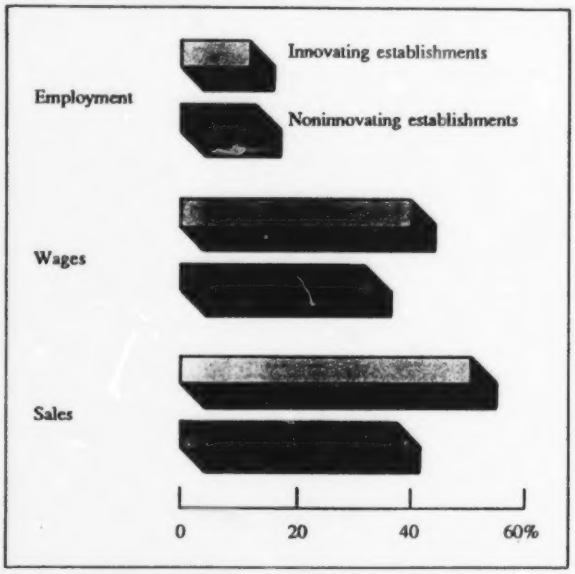
Employment growth in Canada's high-tech sector, 1971, 1981, and 1985



Estimates by the Economic Council based on data from Statistics Canada.

Figure 9

Increase in employment, wages, and sales, innovating and noninnovating establishments, Canada, 1980-85



Based on Betcherman and McMullen, *Working with Technology*.

the employment and output growth performance of intensive users of high technology is stronger than that of mid- and low-tech firms (Figure 9). Wage levels and growth rates were higher among innovators as well. While it is difficult to separate the direct effects of technological change from the host of other factors affecting the performance of firms, further analysis indicates that the strongest influence on employment growth was sales growth itself: businesses that are successful in expanding their sales tend to hire more people. Sales growth, in turn, was influenced by a number of factors, one of which was technological intensity. At the same time, it must be recognized, of course, that successful businesses have more resources to invest in technology.

While our results show that the number of jobs grew more rapidly in those firms which were more technology-intensive, they do not mean that technological displacement did not occur. On the contrary, many adjustments took place within firms as they tried to accommodate the technological changes; as a result, some employees were transferred to other positions, while others underwent training to acquire new skills. Furthermore, many of these technologies were introduced as a means of reducing labour costs, and there is some evidence that some workers were laid off after the technologies were introduced. However, any employment reduction that may

have occurred was more than offset by increases in the volume of business.

Our analysis of the impact of technological change on the labour market leads us to conclude that major shifts are, indeed, taking place in the occupational structure of employment as technological change alters the industrial structure and the mix of occupations within industries. It is clear, as well, that technological change plays an important role in fostering growth in output; unless those higher levels of output exceed productivity gains, however, employment growth will be negligible. Ultimately, increased productivity, particularly if combined with increased product and service quality, translates into higher income levels and increased competitiveness. This, in turn, allows output levels to increase as Canadian goods and services meet with growing success on domestic and international markets. New job opportunities are the end result of this process.

Employment Projections

One of the primary goals of any investigation into the impact of technological change is to acquire an awareness and understanding of the nature and magnitude of the adjustments required. Accordingly, as discussed in Chapter 4 of our research report, our work focused in part on delineating the technological future.

It must be made clear at the outset that the art of forecasting the structure of employment some years into the future is not well advanced. Forecasts of the nature and scale of labour market adjustment are critically affected by three elements.

First, adjustment will depend very heavily on how well the economy performs as a whole. Here, the critical element is the level of demand. If demand is strong, the adjustment process will be made easier since there will be more jobs available overall and, consequently, more "good" jobs – i.e., jobs that are rewarding financially and psychologically. If, on the other hand, the future economy undergoes a period of recession, the adjustment process will be more difficult as fewer jobs overall – and fewer "good" jobs – will be available. The nature and scale of the adjustment task will therefore depend, in part, on how buoyant the future economic environment is; in this sense, forecasts of the impact of technological change are "conditional."

The second critical determinant of the scale and nature of adjustment is how the gains from productivity are shared. Smooth and equitable adjustment comes when productivity growth leads to income and job growth for all. Alternatively, through income transfers, governments can stimulate demand and hence job growth. Or productivity gains may be shared through reduced hours of work. In the final analysis, it is government's responsibility to ensure that the adjustment process takes place smoothly and fairly. This can best be achieved by creating the conditions necessary for strong growth at the macroeconomic level.

Third, it is through changes in the amount and type of labour required that technological change leads to labour market adjustment. Here, the critical element needed for accurate projections of the future structure of employment is knowledge of how the various new technologies affect employment. Very little is known, however, about these effects, about how they might change through time as skills at using the new technologies improve, and about what new effects are likely to develop as the technologies themselves evolve and as new technologies appear. Few models incorporate this element. Accordingly, we have focused our attention on this weakness, incorporating into an employment projection model technical information on how labour requirements change when microelectronics-based technologies are introduced into the office and on the shop floor.

As a first approach to our analysis of employment projections into the 1990s, we used Employment and Immigration Canada's Canadian Occupational Projection System (COPS). The advantage of the COPS model is that, when supplied with industry employment projections for a given period, it is capable of generating projections of employment at a detailed occupational level. Its projections for the period 1987-92 show that sales and service occupations are expected to be among the fastest-growing occupations, while occupations in textiles, farming, fishing, and product fabricating and assembly are expected to be in the fastest-declining group. Overall, however, the high-tech share of total occupational employment is expected to remain fairly constant. It is here that a major weakness inherent in the COPS model becomes apparent. The model is built on the assumption that the occupational shares of industry employment do not change through time. That, however, is a rather mechanistic and naive assumption, for – as our analysis of historical shifts in employment structure clearly shows – technological change does act to cause shifts in occupational staffing patterns. The designers and developers of the COPS model are fully aware of this deficiency and are striving to incorporate this factor into the model.

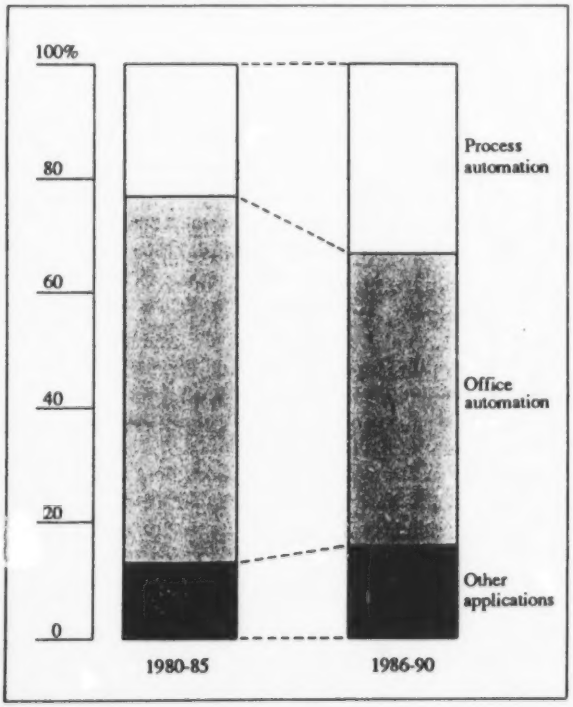
Technological change can take many forms, and, given enough information about the nature of the impact of each type of technological change, it is possible to project those impacts some years into the future. We know from the WWTS results that a great deal of activity

has taken place in recent years with respect to the introduction of computer-based technologies. The survey also provides us with a glimpse into the future, and here we find that some shifts are expected. While office automation is expected to remain dominant (with 51 per cent of all applications anticipated between 1986 and 1990), the emphasis will be redirected somewhat towards more process automation (Figure 10). Consequently, this will require greater adjustment on the part of blue-collar workers than was the case during the first half of the 1980s. Projected growth rates are highest for computer-aided manufacturing (CAM) and computer-aided design (CAD). Within the office technologies group, there will also be a shift in all industries towards increased sophistication and complexity as integrated office networks spread more widely.

Given the growing trend towards wider diffusion of computer-based technologies, it is clear that what is needed is an occupational projection model that incorporates computer-based technological change. Such a model, called MESIM (Microelectronic Simulation Model), does exist. While MESIM has many unique features, one of the most interesting – and most relevant to our purposes – is its ability to identify the bounds within which changes in occupational employment can be expected to occur in future. The upper bound of maximum employment displacement is determined by assuming rapid rates of diffusion of computer-based technological change, with no beneficial feedback effects arising from the "productivity payoff" described earlier. The lower bound of minimum labour displacement is determined by allowing the feedback effects to operate fully, thus permitting redeployment of the workers displaced by technological change. While MESIM does not pretend to forecast exact employment levels for any given year in the future, it does illustrate how the pattern of employment will differ, depending on whether adaptation takes place smoothly or is marred by adjustment failures. Neither perfect adjustment nor complete failure are likely to happen; instead, reality will lie somewhere between the two extremes.

Figure 10

Trends in computer-based technological change in Canada, 1980-85 and 1986-90



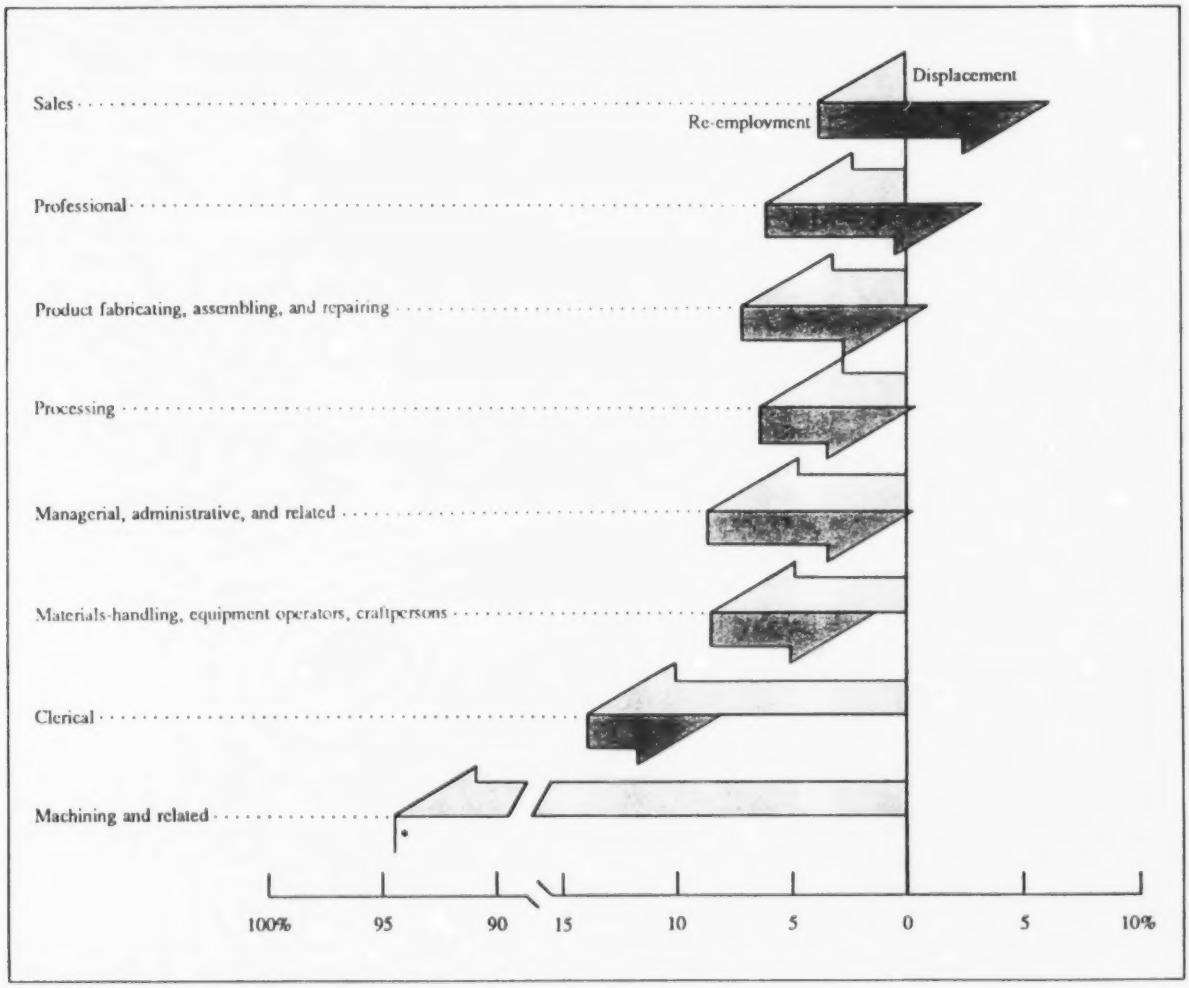
Based on WWTS.

As shown in detail in Chapter 4 of our research report, MESIM has both an industry and an occupational employment dimension. Here, we summarize the occupational results (Figure 11). First, we find that the impact of technological change is highly uneven across occupations. Second, it has the potential to cause considerable worker displacement. But, third, the indirect employment-generating effect arising out of the productivity payoff can be large. In fact, such indirect positive effects more than offset the displacement effect in sales, in professional occupations, in product fabrication, assembly, and repair, in processing, and in managerial, administrative, and related occupations. Certain other occupations may, however, experience considerable net job losses. These include most notably machining and related occupations, and clerical occupations; but materials-handling, equipment-operating, and crafts occupations are also negatively affected. Even for the many occupations where the size of the two opposing effects is more or less in balance, adjustment problems will likely remain, since available employment opportunities must be matched by the skills of the available work force.

What MESIM does is to show, in principle, the possible limits within which displacement and re-employment may be expected to occur. In practice, the full extent of displacement may not be realized, because the extreme case of rapid diffusion may not hold. Nor may the full extent of re-employment be realized, because complete adjustment may also be difficult to achieve in practice. Where Canadians will end up between these two limits will depend on how well they retrain and adapt. Everything that Canada does to foster the effective use of the new technologies will bring it closer to full re-employment of the workers displaced. It is for precisely

Figure 11

Projected change in Canadian employment to 1995, relative to 1981 levels, by occupational group



*Projections indicate virtually no re-employment (0.4%).
Based on MESIM results.

this reason that we devote the remainder of this Statement to various aspects of adjustment. To get the fullest possible payoffs from productivity growth, Canadians must focus on the management of innovation, constructive industrial relations, and the adjustment needs of disadvantaged groups.

Is There a Declining Middle Class?

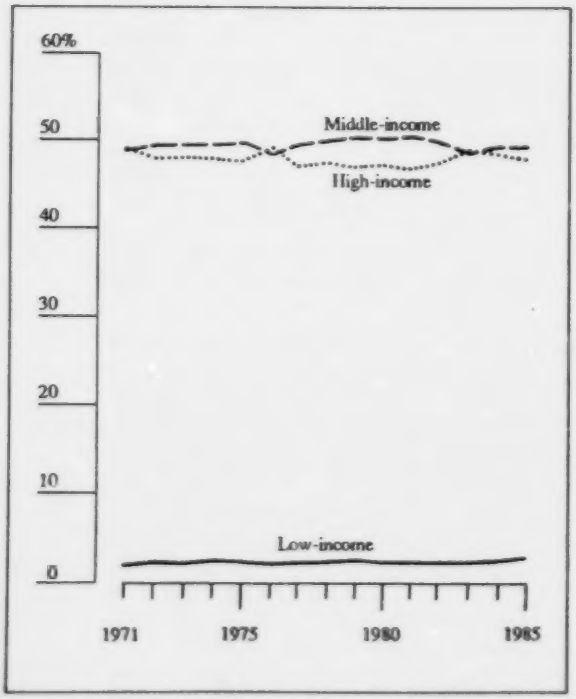
A major debate is currently raging about whether technological change is having negative consequences for the distribution of income that, in the end, manifest themselves in a decrease in the size of the middle class. This "declining middle" is held to be the end result of a process whereby technological change causes an uneven or skewed distribution of skills and, consequently, a skewed occupational distribution. It is argued, for example, that within the high-tech sector, the new technologies are creating both high- and low-skill jobs, but few middle-level jobs. Furthermore, within the economy as a whole, it is contended that the new technologies play a major role in the shift from goods production, where traditionally many of the middle-class jobs have been found, to the service industries, where many of the jobs are held to be low-paying and part-time. Our interest in the "declining middle" debate arises, of

course, out of the very profound consequences that such a development, if it occurred, would have for society, since a widening gulf between the "haves" and the "have-nots" would almost certainly lead to social unrest. Those at the bottom would have little opportunity for advancement, while the lack of a large and stable consumer market would present a major handicap for the producers of goods and services. Even more fundamentally, Canadian society would no longer rest upon the foundations of equity and fairness.

When we examined the income distribution patterns for the period 1971-85, we found that the respective shares of income going to the high-, middle-, and low-income groups have been remarkably stable (Figure 12). We could not, however, overlook the possibility that the myriad other forces that act to shape the distribution of income are compensating for any negative impact arising out of technological change. Consequently, we undertook a three-pronged analysis designed to disentangle the effects of technological change from these other effects. The details of this work are reported on in Chapter 5 of our research document.

Figure 12

Income distribution in Canada, 1971-85



Estimates by the Economic Council based on data from Statistics Canada.

First, we find that the high-tech sector created the bulk of all jobs in the economy during the period 1971-81 and contributed even more strongly to the growth of middle-income jobs. Second, an examination of the quality of the emerging skills, as measured by the education requirements of jobs, suggests that the fastest-growing jobs during that period were high-skill jobs, while the jobs in fastest decline were low-skill ones. These results are not conclusive, however, since they do not take into account some other important considerations, such as the growth in part-time employment and changes in the demographic structure, in educational attainment, and in family structure. Furthermore, the analysis ends in 1981, the most recent census year available. Accordingly, a third, more exhaustive analysis was undertaken that took into account the impact of changes in the occupational and industrial structures, as well as factors related to age, sex, family type, and education. Here, we do not find conclusive evidence of a declining middle class in Canada.

There are enough signs pointing to the possibility of middle-class erosion, however, that we feel it is important to sound a note of warning. First, in many respects, we are still only at the early stages of the current wave of technological change. New advances in computing power, the development of new applications, and the progress being made in other technological fields – such as biotechnology, laser and sensor technologies, and advanced materials – all promise to cause further changes in our working and home lives. Furthermore, Canada is lagging behind in the application of many of these technologies, and it may be that the process is still at an early enough stage that clear signs of middle-class erosion just have not yet appeared. In the United States, where technological change is further advanced, there are some indications that middle-class decline may have begun, as smokestack industries cut back production and lay off blue-collar workers, and as evidence of a growing number of low-skill, low-paying jobs in the high-tech industries emerges. The question of whether clearer signs of a "declining middle" are appearing in Canada will be examined in a background study that will extend the analysis to 1986, the most recent census year.

Second, there are some disquieting signs that while there has been little change in the size of the middle class overall, a great deal of movement is taking place under the surface. Some traditional industries are getting smaller, as other countries challenge Canada's position as a supplier of natural resources to the world economy and as the newly industrializing countries put into place the technologies and expertise necessary for successful international competition; and others are growing but providing many low-paid, low-skill jobs. So while the

benefits of economic growth are large and positive overall, in individual cases there are costs involved.

Thus a word of caution is appropriate here. Occupational shifts take place over time in response to changes in technology, in international trade patterns, or in economic trends. While these shifts may or may not cause changes in the size of the middle class, they almost certainly alter its composition.

Society as a whole benefits from economic growth as income and employment grow. If the principle of equity is to be maintained, society must assist those individuals who may be adversely affected. Part of this assistance should consist of equipping workers with the skills required to make the transition to new types of jobs and to handle the new technologies. That is why training and retraining form such a critical part of the policy package recommended in the final section of this Statement.

* * * * *

Our analysis of recent changes in the structure of employment highlights the complexity and unevenness of the effects of technological change. Its direct impact on employment in most occupations, notably machining and clerical, is negative. But the direct effects are countered by the productivity payoff. What this means in practical terms is that Canadians face a major challenge of adjustment. If this challenge is met successfully, the job growth potential of the new technologies can more than offset their displacement effects. That is precisely why we focus on the creation of the right climate for adjustment in the remainder of this Statement.

In analysing the impact of technological change on the size of the middle class, we have found no conclusive evidence, so far, of middle-class erosion. Canadians should not be complacent, however. As the new technologies evolve and spread, they may yet be accompanied by clearer signs of shifts in the distribution of income. Even more fundamentally, the natural consequence of change – historically and in the future – is that some individuals profit while others lose. Changes in the composition of the middle class, as well as concern for those who suffer a deterioration in their standard of living as a result, must be reflected in the policies that are put into place to facilitate adjustment.

The challenge we face, therefore, is to create a system that fosters technological change, building upon its positive impact while minimizing its negative effects. What is needed is an industry structure and a labour force that are adaptable in the face of change and that are responsive to it. Accordingly, adjustments within firms will be required; but, more broadly, adjustments must also be made by individuals and by governments.

4 Workplace Innovation

Technological change does not happen in isolation: not only does it alter the types of skills that a firm requires, but it also creates pressure for new ways of designing jobs and structuring the decision-making process. In short, organizations must change as technologies change. Traditional hierarchical relationships, repetitive assembly-line tasks, and centralized control do not provide a suitable environment for making the most of the new technologies. In the end, successful innovation means much more than new machinery and equipment. As Japan and Sweden (among others) have demonstrated, success also requires an innovative organizational climate that can foster an involved, well-trained, and committed work force. In Canada, while almost everyone agrees that people are the key, too few organizations live by that principle.

We need to deal with the human side of innovation now, simply because technological advance is rapid. According to the Working with Technology Survey, 85 per cent of Canadian establishments expect to have some computer-based technology by 1990. Survey respondents estimate that by that time, 39 per cent of their employees will be using microelectronics technology in their jobs, compared with 16 per cent in 1985. Put another way, this means that for every 100 persons working directly with computerized equipment in 1985, it is expected there will be 262 by the end of the decade.

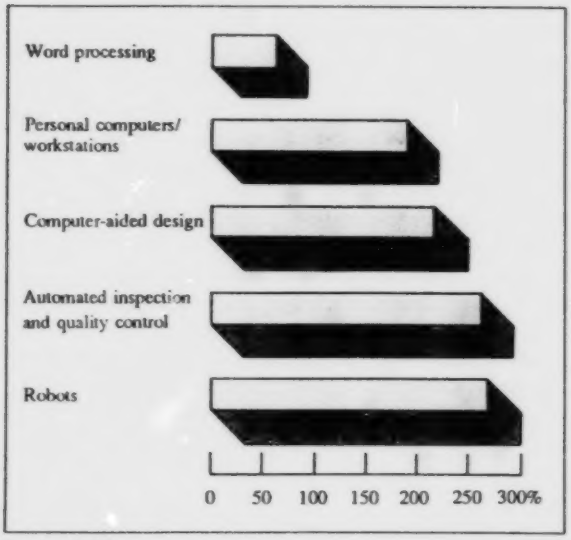
Moreover, increasingly diverse types of workers will be brought into the microelectronics world in the final years of the decade. We showed earlier that the Canadian experience with computer technologies to date has been limited in large part to office automation. As a result, it is the white-collar workers who have been affected the most by computer-based technological change. The widening application of process technology, however, is expected to feature prominently in the adoption of innovations in this country during the rest of the 1980s. Thus the number of people working with technologies like robots and computerized quality control will likely rise dramatically (Figure 13). Indeed, a conclusion of our research is that what lies ahead may well be quite different from what has been experienced up to this point.

Retraining

The magnitude of these changes – and their implications for human resource development – must be recognized by Canadians. The pace of innovation calls for

Figure 13

Projected increase in the number of workers using selected technologies, Canada, 1985-90



Based on WWTS.

a range of responses by firms and other organizations. For example, the WWTS results indicate that most computer-based technological changes require new skills. Thus retraining is obviously one very important organizational response. Indeed, two-thirds of the innovating firms in the survey sample reported that they had provided some retraining in response to the introduction of computer technologies (Figure 14). While most of these firms do some technology-oriented retraining, much of the activity carried out so far appears to have been informal and of relatively short duration, predominantly aimed at simply adapting existing skills to new equipment. This retraining has been heavily concentrated in white-collar occupations – not surprisingly, given the importance of office automation until now (Figure 15). Clerical workers, in particular, have been the focus of much of this effort: over one-half of the retraining programs reported involved this occupational group. Where the new technologies changed higher-level skills, companies seem to have opted for hiring new employees rather than retraining current ones.

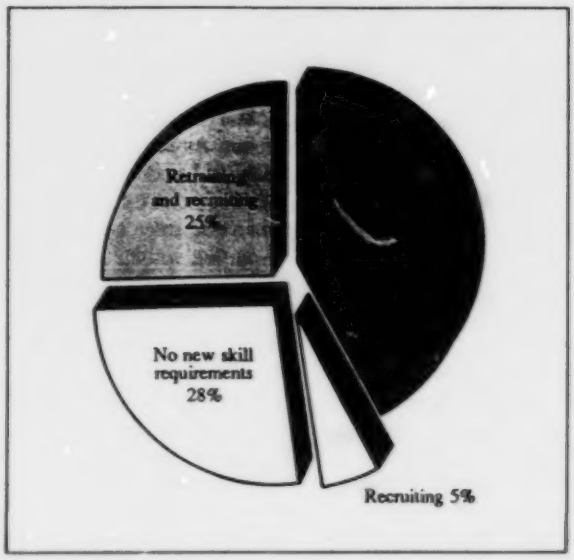
Our case studies have shown how critical the presence of a well-trained work force is to the optimal performance of the new technologies. However, while we found instances of very substantial employer-sponsored retraining, the survey results suggest that they are not typical. On balance, our research does not provide evidence of major skills development on the part of Canadian industry in response to the computer technologies introduced so far. In our view, this indicates an overall undertraining in response to technological change. This conclusion is supported by recent evidence suggesting that Canadian workers get about two hours of in-plant training annually, compared with 100 to 200 hours for their Japanese counterparts.

But companies may have been able to get by without major retraining efforts until now, because the bulk of computer innovations so far has consisted of relatively small, stand-alone office applications, with only a modest impact on skills. The larger-scale, more integrated systems that are expected to spread in the remainder of the decade will almost certainly call for a considerably greater effort in human resource development.

Training must be an important element in an innovative organization's approach to change. It is critical for a full exploitation of the new technologies; it also signals a commitment to the work force. Yet organizational innovation goes far beyond training. It includes a wide range of initiatives – with respect to structure, policies, and even "corporate culture" – that maximize the contribution that people can make to the firm's success. Some of these initiatives are described in Figure 16. Our case studies show that the motivation for these workplace

Figure 14

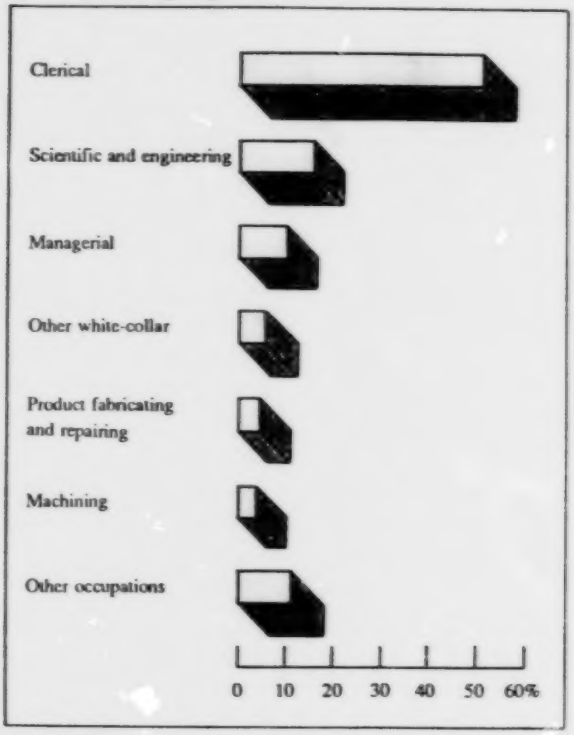
Approaches used by Canadian establishments to meet new skill requirements, 1980-85



Based on WWTS.

Figure 15

Training programs in Canadian establishments, by occupational group, 1980-85



Based on WWTS.

innovations is that they lead to better corporate performance.

Work Organization and Decision-Making

There are two essential ingredients in organizational innovation – job redesign and worker participation. The first involves the design of jobs, as well as the roles, tasks, and responsibilities of the persons who perform them. For example, job enlargement and job rotation widen the range of tasks to which workers are exposed, while job enrichment gives them additional responsibilities. Work designs along these lines are sometimes associated with novel forms of compensation – such as pay-for-knowledge, which is intended to encourage and reward employees for the skills that they are able to bring to the workplace. There are a variety of benefits attached to innovative schemes of work organization: for the employee, there is the challenge and reward of learning more than just how "one cog in the machine" works, which, for the company, can pay off in increased flexibility and improved problem-solving.

The second ingredient entails structures and procedures for the participation and, hence, commitment of workers. The key here is the involvement of workers in a variety of decisions that have a bearing beyond the immediacy of the tasks they are carrying out. Innovations in decision-making can vary considerably in scope, ranging from "quality circles," in which groups of workers and their supervisors examine techniques to enhance productivity and quality, to forms of industrial democracy, where employees may be involved in the broader policy issues of the enterprise. Here, too, there may be associated compensation innovations, such as gains-sharing schemes in which employees receive a bonus based on productivity improvements or cost savings.

Comprehensive models of organizational innovation contain elements of both job redesign and worker participation. The ultimate embodiment of such principles is the "sociotechnical systems" approach. This involves the mutual accommodation of the technical and social needs of the organization in the change process. A cornerstone of the sociotechnical systems model is the semi-autonomous work group – a team having collective responsibility for a complete operational unit. Members tend to be multi-skilled – i.e., to be able to perform all of the tasks in their area. Typically, these groups enjoy considerable independence in planning, integrating, executing, and monitoring production within their work unit. As they mature, they may increasingly take on a wide range of support functions, including maintenance and such personnel matters as work and vacation schedules, and so on.

There are some well-known cases of innovative organizations in this country, which are documented in *Workplace Innovation in Canada*, a study prepared for the Council by Jacquie Mansell. The sociotechnical systems approach, for example, is in place at the world-famous chemical plant of Shell Canada in Sarnia, Ontario, and at the General Electric plant in Bromont, Quebec; it will also be used in Pratt and Whitney Canada's new Halifax operations.

What have been the advantages of these workplace innovations? In our own case studies, we encountered many of the organizational innovations described above (Figure 17). The most frequently cited gains included: productivity increase; cost reduction; lower absenteeism; reduced turnover; improved attitudes; better safety records; fewer grievances; and enhanced quality.

How commonplace have the organizational innovations described here become within Canadian industry? Evidence from the WWTS indicates that 65 per cent of the establishments surveyed reported that they had

Figure 16

Selected innovations in organizational structure

EI	employee involvement – EI programs provide regular means of giving employees information, obtaining feedback and involving them in problem-solving.
ESOP	employee stock ownership plans – these enable companies to allocate stock to employees, usually based on salary or seniority.
Flexitime	way of organizing working time that allows workers to come and go as they choose, within certain limits, as long as they work a prescribed number of hours each week.
Gains-sharing	schemes that allow workers to share the gains from increased productivity by earning a bonus; they include Improshare and the Rucker and Scanlon plans.
Industrial democracy	may take the form of labour participation in national economic planning or on boards of directors, or of workers asserting their rights and responsibilities through more conventional means like collective bargaining.
Just-in-time (JIT) inventory management	reduction of inventory levels through delivery of parts to assembly line as needed.
Organizational effectiveness	umbrella term that covers numerous workplace innovations (e.g. QWL, STS, EI and gains-sharing) that emphasize human needs while improving productivity.
Participative decision-making	schemes used to tap workers' expertise and provide sense of commitment; they run the gamut from outright worker ownership of the enterprise, through representation on the board of directors, to opportunities for information exchange.
Pay-for-knowledge	approach to remuneration that supports concept of multi-skilling; workers are encouraged to learn to perform a variety of functions, and the more they learn, the more they are paid.
Quality control (QC) circles	small groups of employees, engaged in day-to-day operations at the plant level, that help identify production problems, devise plans for solving the problems and help put solutions into practice.
QWL	quality of working life – takes into account not just hours and pay but opportunities for fulfilment and satisfaction associated with working, e.g. how jobs are designed and remunerated, and job satisfaction through involvement in decision-making.
Semi-autonomous work groups	work is organized so that groups take major responsibility for decisions such as hiring, workflow, scheduling and quality control.
SPC	statistical process control – use of basic statistical concepts to monitor how consistently products fit engineering specifications.
STS	socio-technical systems – approach to working that explicitly incorporates needs of both technical and social (human) aspects of organizational design.
Venture team	team of workers formed to "buy" an innovation from an individual or section in an organization and to bring that idea to the commercialization stage.

From Words Associated and K. Newton, *Workable Futures*, Economic Council of Canada, Ottawa, 1986.

Figure 17

Economic Council's case studies on technological change

Industry	Province	Technology	Features
Aircraft engine manufacturing	Nova Scotia	• Computer-integrated manufacturing (CIM)	• Sociotechnical planning • Semi-autonomous work groups • Pay-for-knowledge
Automobile engine manufacturing	Ontario	• Robots • Statistical process control (SPC) • Just-in-time inventory (JIT)	• Training
Computer services	Alberta Ontario	• Computer-assisted learning (CAL) • Artificial intelligence (AI) • Office automation	• High-tech based growth • Futurist innovations
Electrical and electronic assembly	Ontario	• Robots • Statistical process control (SPC) • Just-in-time inventory (JIT)	• Productivity gain-sharing
Federal government	Quebec	• Office automation	• Relocation • Retraining
Federal government	Ontario	• Office automation	• Semi-autonomous work groups • Retraining
Metal-container manufacturing	Ontario	• Office automation	• Union-management committee
Pulp and paper	New Brunswick	• Production automation	• Retraining • Planning
Rehabilitation	British Columbia	• Various	• Training disabled workers
Various manufacturing	Quebec	• Various	• Sources of failure

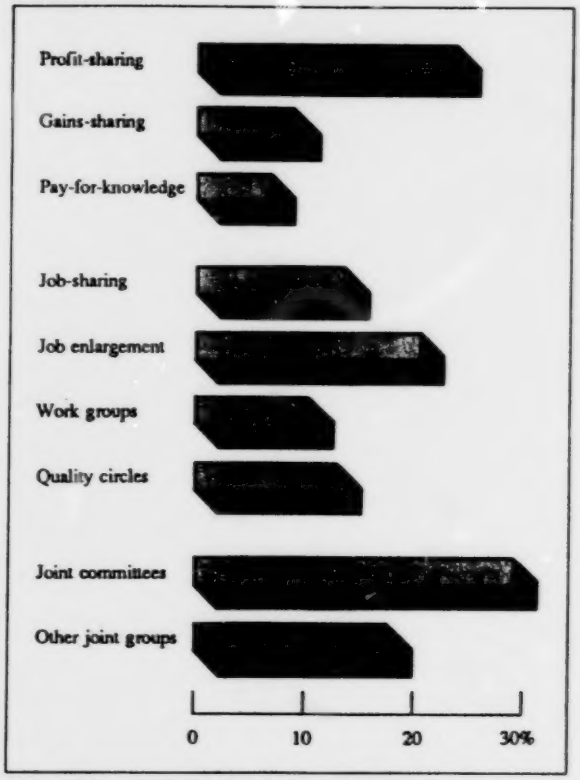
From G. Betcherman and K. Newton, "A case book on technological and organizational change," Economic Council of Canada (forthcoming).

implemented some form of organizational innovation (Figure 18). The most common initiatives are decision-making arrangements. Nearly 30 per cent of the respondents, for example, have joint labour-management committees.

There is evidence, however, that these committees tend not to have a major participative role, at least with respect to the process of technological change. The introduction of new technologies involves a number of critical decisions about the types of equipment required, the scale of implementation, the reorganization of the work process, and so on. The traditional practice, of course, has been for management, alone, to make these decisions. The survey results suggest that it is no longer unusual, especially within large firms, to involve consultants and technical vendors in the planning process. The participation of workers or their representatives in the

Figure 18

Organizational innovations in Canadian establishments, by type, 1980-85



Based on Betcherman and McMullen, *Working with Technology*.

innovation design team was reported far less frequently, however.

Although work-organization innovations are occurring in Canada, most Canadian firms stick to relatively traditional practices. Schemes to redesign jobs through enlargement, rotation, and enrichment were practiced by fewer than one-quarter of the survey respondents, while 13 per cent had adopted the Japanese-style quality circles. Job-sharing, an organizational innovation that has received popular attention as a means of accommodating individual preferences for less than full-time work, was also infrequently reported. Furthermore, the shorter-hour arrangements that do exist do not always turn out well for employees, since some compensation benefits are unavailable to part-time workers. There is evidence of innovative compensation arrangements in the form of profit-sharing, gains-sharing, or pay-for-knowledge but, again, these appear to have been implemented by a relatively small number of firms in this country.

Ultimately, of course, it does not matter how many firms have a specific form of workplace innovation, such as quality circles, venture teams, or gains-sharing. No single approach is a panacea. Some highly innovative schemes may have no special name; other schemes with attractive titles may be no more than temporary fads. The important point is that the best companies have a commitment – and a *continuing* commitment – to workplace innovation. As pointed out by Thomas J. Peters and Robert H. Waterman, Jr., in their book *In Search of Excellence* (New York, Harper & Row, 1982):

> Most of the excellent companies ... *do* have quality circles and they probably *have* tried team building, and maybe they still use all of these. But they have lots more .... We found rich systems of monetary incentives; but we expected that. We also discovered an incredible array of nonmonetary incentive and an amazing variety of experimental or newly introduced programs. *No one device – even in the best of institutions – is likely to be effective indefinitely.* The point is to treat the problem as one would the new product challenge. The pipeline must always be filled with the next score of candidate programs (p. 242; emphasis added).

* * * * *

The value of various forms of organizational innovation is being recognized by increasing numbers of Canadian firms; and, indeed, we have seen some highly visible and successful examples of new working arrangements. On balance, however, it appears that many firms in this country are operating according to traditional principles of work design and decision-making. To be fair, organizational change clearly poses considerable challenges both for managers and for workers and their unions. Nevertheless, far too many Canadian firms pay only lip service to the "people" side of the enterprise.

The challenge for Canadians is to develop a widespread understanding that innovation is not just robots and computers: equally important are organizational advances that maximize the contribution that people and the new technologies, together, can make. For organizational change to flourish, there must be imagination, commitment, and motivation.

5 Industrial Relations

Our primary focus in examining the interrelationship of technological change and industrial relations is the way the new technologies are affecting the collective bargaining system. The analysis on which this discussion is based can be found in Chapter 8 of our research report.

The concept of the involvement of workers in decisions about technological change was emphasized in the preceding section. Participation on the part of all of those who have a stake in such change is necessary for effective technological and organizational innovation. On balance, however, our research suggests that, while progress is being made, there is still not enough constructive dialogue in this country between unions and employers over issues involving technological change. Genuine collective bargaining over the implementation of new technologies is an important policy objective, and our analysis suggests the need to consider ways of better achieving this objective.

Industrial relations systems in most developed countries are being subjected to great pressures in the increasingly competitive international economy of the late twentieth century. The systems based on collective bargaining, in particular, are currently threatened. That is perhaps most evident in the United States, where a declining union movement, more-aggressive employers, and public policy shifts are pushing labour "against the ropes." In contrast with the situation south of the border, unionization has not declined in this country nor has there been a perceptible shift in the support of public policy for collective bargaining.

Nevertheless, there are serious challenges here as well. Much of the growth in Canadian unionism over the past two decades has taken place in the public sector. With the exception of some industries, collective bargaining coverage in the private sector has stood still or even declined. To some extent, this is due to structural shifts in the economy, with employment growth in recent times taking place in industries that have no union tradition. As well, the fiercely competitive economic environment of the 1980s – with corporate emphasis on cost-cutting and operational flexibility – has been an unfriendly one for collective bargaining.

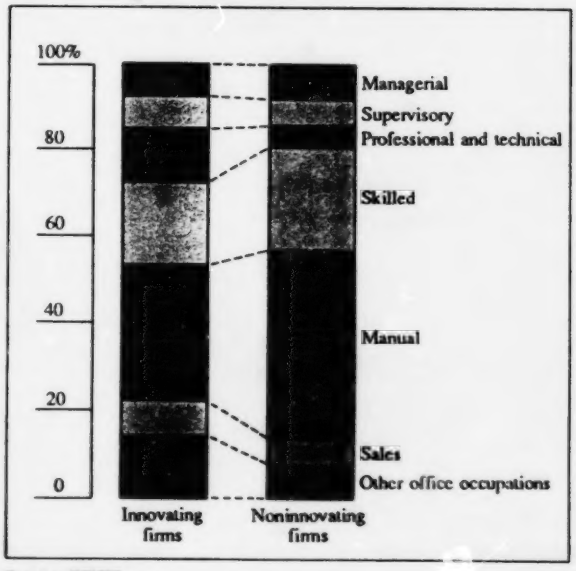
This is not a good time, then, for existing collective-bargaining institutions. And the new technologies, now woven into the prevailing context, are, in a sense, part of the issue. In the first place, they appear to be threatening union membership by accelerating employment shifts away from traditionally unionized occupations. Our analysis indicates that the extent of collective bargaining in Canada is the lowest in those industries which we have identified as "high-technology." Although bargaining coverage has grown considerably within some white-collar occupations over the past two decades, union membership, particularly in the private sector, remains mostly concentrated among blue-collar workers. While there is a long-term trend away from blue-collar employment in general, it seems that this trend is more marked where computer-based technological change is taking place. Employment for skilled and general manual labour – again, the traditional source of union membership – was significantly less important among our survey respondents identified as innovators than among non-innovators (Figure 19).

A second area of concern involves the implications of technological change for the relative bargaining power of unions and employers. There are many different factors determining the distribution of bargaining power, and as these factors change, the balance shifts as well. The fundamental source of power for unions rests with the collective indispensability of workers in production. It has been argued that technological change, at least in some situations, offers employers the potential for controlling production away from the shop floor. Where the new technologies diminish the indispensability of union labour, and, particularly, where they enable the maintenance of operations during a strike, the balance of power may shift considerably.

Overall, it is likely that the effects of the new technologies depend very much on how the latter are implemented. Innovation need not be a game of winners and losers, however. Research suggests that, in a collective bargaining setting, all parties benefit when

Figure 19

Occupational structure of Canada's innovating and noninnovating establishments, 1985



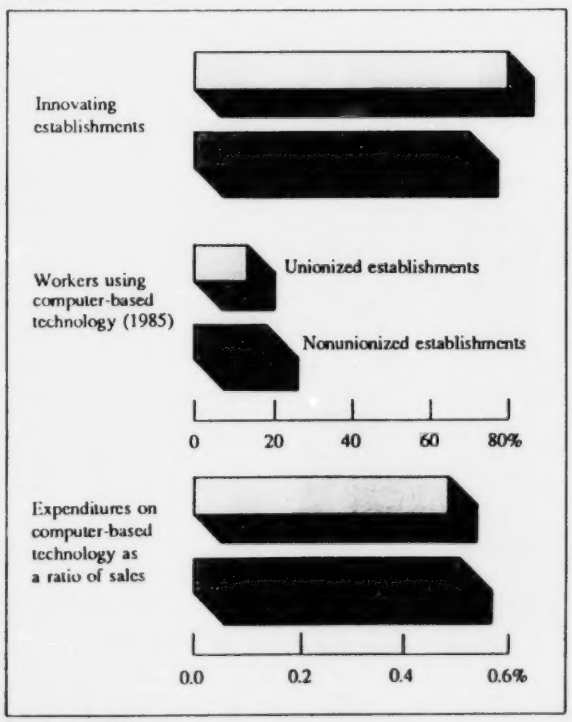
Based on WWTS.

management and union work together and, formally or informally, negotiate agreements on technological change. In this document, we have tried to emphasize the value of genuine participatory approaches to technological change. We have also recognized that, for a variety of reasons, these approaches are not easy to implement.

In the first place, employers must be prepared to involve workers and their representatives in the innovation process, which implies giving up some control over what has traditionally been managerial prerogative. Workers, for their part, should not be opposed to the idea of change. There is a perception that the rigidity of labour is, indeed, an obstacle. The information we have gathered, however, consistently indicates that Canadian unions and their members generally are not opposed in principle to technological change. And, certainly, we have seen no evidence suggesting that innovation is not taking place in union settings. According to the WWTS results, there is no correlation between the presence of a union and the extent to which the new technologies have been introduced into Canadian establishments (Figure 20).

Figure 20

Innovation and unionization in Canadian establishments, 1980-85



Based on WWTS.

Whatever negative attitudes do exist among labour seem to pertain not so much to technological change itself but rather to the ways in which it is implemented. The dominant feeling expressed by union officials in a survey conducted in the early 1980s was that technological change was acceptable "as long as consultation precedes the introduction of change, and management undertakes to make every effort to minimize the adverse effects on workers." Similar conclusions emerge from the spate of union-oriented research sponsored recently through Labour Canada's Technology Impact Research Fund.

Collective Bargaining over Technological Change

In the Canadian model predicated on collective bargaining, the conditions of employment that are of concern to unions and employers are, ideally, negotiated by both parties. The question is, however, whether the issues raised by technological change are being worked out through this mechanism. There is no easy answer. While we looked at the extent to which collective agreements contemplate innovation and its impact, experienced participants in bargaining recognize that formal provisions and actual practice are not always the same. Nevertheless, written agreements are the "rule book" governing the union-management relationship; as such, they are an important source of information. Accordingly, we tracked the incidence of relevant provisions across industries and jurisdictions, and over time. Our analysis was based mainly on the contents of agreements in bargaining units with more than 500 members. This was supplemented by an examination of a randomly selected sample of 183 agreements covering fewer than 500 workers.

Before turning to our results, it is important to note that four Canadian jurisdictions have passed legislation intended to support collective bargaining over technological change. At the federal level, for example, the *Canada Labour Code* stipulates that an employer who proposes to introduce technological change likely to affect a significant number of employees must notify the union 120 days in advance. The union can then apply to the Canada Labour Relations Board for permission to bargain over those parts of the contract likely to be affected by the proposed change. When such an application has been filed, the employer cannot legally introduce the technological change until the board has rejected the application, until a negotiated settlement has been reached, or until the parties are in a legal strike/lockout position. Very similar statutory provisions also exist in Manitoba and Saskatchewan. The fourth jurisdiction,

British Columbia, has a somewhat different legislative approach, which we shall discuss later.

Our analysis shows quite clearly that technology-related clauses are found in only a minority of Canadian labour contracts. Moreover, the incidence of such clauses is much lower in agreements covering fewer than 500 workers than in those covering a larger bargaining unit. The clause providing for advance notice prior to the introduction of technological change is the most common of these provisions (Table 1), but it is not included in over 60 per cent of the agreements examined. Other technology-related provisions are even less frequent. Considerable differences are found in the incidence of such clauses across industries; they are more prevalent in older industries, often with static or declining employment growth.

An important policy-related question concerns the impact of the legislation for negotiating technology-related clauses. Has it, in fact, led to a higher incidence of such clauses? In all four jurisdictions, the statutory provisions were enacted in 1972-73; accordingly, we traced the frequency of relevant clauses since that time. Our analysis indicates that any change in incidence has, on the whole, been rather modest. Moreover, whatever increase in frequency there was took place, for the most part, long after the immediate post-legislation years. Finally, the evidence does not indicate that the incidence of technology-related clauses is consistently higher in the four jurisdictions with relevant legislation than in the others. Of the four, only British Columbia is among the jurisdictions with the greatest frequency of clauses dealing with technological change in collective agreements.

Not only is technological change and its impact rarely contemplated explicitly in Canadian contracts, but there has been little enforcement of the obligation to bargain and weak interpretation of technology-related clauses by labour boards and arbitration panels. With the partial exception of British Columbia, the boards have almost never granted leave to open bargaining over the introduction of new technology. A review of board decisions and arbitral awards suggests that there are a number of problems involved in enforcing clauses dealing with technological change. First, because the definitions of what constitutes "technological change" tend to be very restrictive, the relevant statutory and contractual provisions are often not called into play. The requirement that "significant" numbers of employees be involved has also posed problems. As well, boards and arbitrators have often faced difficulty in separating the effects of technological change from those of other factors.

Finally, the issue of "opting-out" provisions must be recognized. Three of the four jurisdictions with statutory provisions for negotiating technology-related clauses allow the parties to an agreement to opt out of the legislation if the agreement contains clauses for the resolution of issues created by technological change. In the federal jurisdiction, the contract may simply stipulate that the *Canada Labour Code*'s provisions on technological change do not apply. While the intention of the opting-out provisions may have been to encourage the parties to negotiate, our analysis suggests that they do not stimulate genuine bargaining over technological change.

British Columbia is the only jurisdiction without the opting-out provision. In this and other respects, the approach for dealing with industrial relations issues associated with innovation appears to be more effective in that province than anywhere else in Canada. The *British Columbia Labour Code* requires that every agreement

Table 1

Frequency of provisions related to technological change in collective agreements,[1] Canada, 1972-85

	Proportion of agreements covered						Proportion of workers covered					
	1972	1978	1980	1982	1984	1985	1972	1978	1980	1982	1984	1985
	(Per cent)											
Provisions for:												
Advance notice or consultation	27.4	28.5	33.5	35.5	38.1	38.0	35.5	34.9	40.2	41.6	42.7	42.1
Training/retraining	22.7	21.7	25.5	28.7	31.1	31.1	28.1	27.8	29.9	32.5	31.5	31.5
Labour-management committee (on technology-related issues)	13.9	12.3	14.9	14.7	14.3	14.6	17.3	21.0	25.6	22.3	20.8	22.2
Employment security (technology-related)	12.1	18.1	19.9	21.2	21.9	22.7	15.2	23.8	24.7	24.1	24.0	25.4

1 Agreements covering 500 or more workers; agreements in the construction industry are excluded after 1978.
Estimates by the Economic Council based on data from Labour Canada.

contain provisions for addressing technology-related concerns. When disputes cannot be handled privately, the matter may be referred to an arbitration panel that is empowered to prescribe a range of remedies. Perhaps as a result of the legislative differences, board and arbitration decisions in British Columbia have diverged from the national mainstream on a number of important issues, including the definition of technological change.

* * * * *

It must be recognized that collective bargaining has led, in some instances, to effective handling of innovation. In the final analysis, however, our review suggests that there is not enough real negotiation over the introduction of new technologies and their impact. Technology-related provisions are relatively infrequent; and, where they do exist, they tend to be weakly enforced. The voluntary negotiation of employment conditions through the mechanism of collective bargaining has been a cornerstone of Canadian public policy in industrial relations. The technological change provisions contained in the *British Columbia Labour Code* seem to offer the framework most likely to encourage serious and productive negotiations.

To be effective, industrial relations in this area must include – but also go beyond – the formal collective-bargaining system. In countries that rely on the collective bargaining approach – the United States, the United Kingdom, and Australia, for example – there is little real negotiation on technological change, and such provisions as do exist tend to be defensive in nature. Obstacles come from the presumption that the introduction of new technologies is a managerial prerogative, as well as from the inability of unions to treat this issue as a bargaining priority. An additional constraint of the collective bargaining approach is its limited coverage. In Canada, at least half of the work force appears to be outside the system of collective bargaining.

We have looked at other countries to see how they handle industrial relations issues associated with technological change. In some – Sweden and Japan, to take two quite different examples – labour, as well as management, is involved in innovation and adjustment questions. Where this takes place, technological and organizational change is seen positively, by both employers and workers, as a tool for enhancing both economic performance and the workplace environment.

The challenge for Canada is to develop an effective industrial-relations approach to technological change, based on its unique collective-bargaining system. The approach must encourage joint involvement and decision-making. It must also facilitate the negotiation of mutually satisfactory conditions with respect to operational flexibility, employment security, and the sharing of the productivity dividend. Such a framework is essential if Canada is to cope effectively with the pace of change that we anticipate for the future.

6 Women and Special Groups

Some Canadians face special risks in dealing with technological change. Women, for example, are identified with some of the occupations most affected by technological change. At the same time, many older workers have more trouble learning new skills; and native people are often disadvantaged by their concentration in certain industries and in more remote regions. In this section, we review the concerns of these and other special groups.

Women and Technology

For women generally, the new technologies hold out prospects of both benefit and bane. A fuller discussion, including detailed background statistics on developments in female employment in Canada's high-tech sector and case studies of the adaptation of women to technological change in the public service, is contained in Chapter 9 of our research report. For present purposes, we concentrate on a few major findings to which we attach special importance.

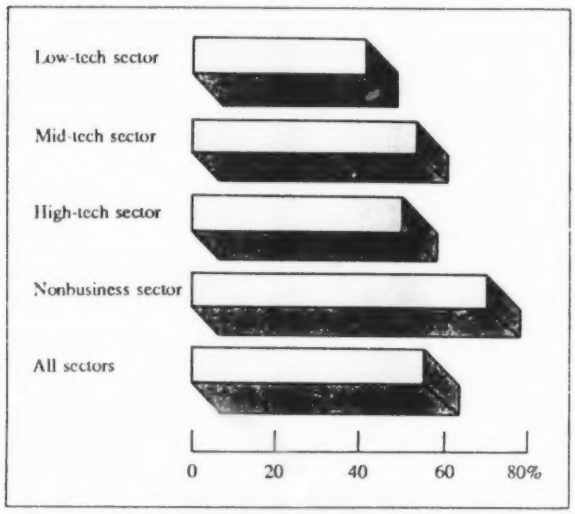
Earlier, we noted the healthy employment growth that has taken place in the high-tech sector of Canadian industry. A glance at Figure 21, which shows the proportion of employment growth accounted for by women, suggests that they received their fair share of new high-tech jobs.

It is important, however, to look behind the employment numbers and examine the quality of the emerging job structure for women. By the beginning of the 1980s, some ominous causes for concern were already apparent. First, within the high-tech sector, female employment was very heavily concentrated in three main industries – retail trade; finance, insurance, and real estate; and services to business. What is noteworthy about these industries is that they employ very high proportions of clerical workers. There are signs, therefore, that the disturbing traditional tendency towards the "ghettoization" of women in clerical occupations is continuing in the high-tech sector.

Next, it appears that women in the high-tech industries do not necessarily earn the highest incomes. Indeed, for a

Figure 21

Women's share of employment growth in Canada, 1971-81[1]



1 For an explanation of "low-tech," "mid-tech," and "high-tech," see the footnote to Figure 7. The nonbusiness sector includes education and health services, social services, religious organizations, household services, and public administration and other government offices.

Estimates by the Economic Council based on data from Statistics Canada.

range of clerical occupations in the year 1980, the average employment income in the high-tech sector was consistently below that in the low-tech sector. This may be attributed in part to the volatility of the high-tech sector: many new firms appear, but the "death rate" of firms is high, too. Thus employees may not have accumulated the experience and seniority that bring higher earnings.

In any case, some recent technology-related labour market developments compound our concern about the quality of women's employment. Part-time work has been on the increase in recent years, and almost three-quarters of it is accounted for by women. Figure 22 shows recent developments in part-time work for some occupational groups with heavy concentrations of women. The trend is certainly related to the strong desire to cut labour costs, following the experience of the recent recession. We believe it is also due, in part, to the productivity effects of the new technologies, making part-time work more feasible for employers.

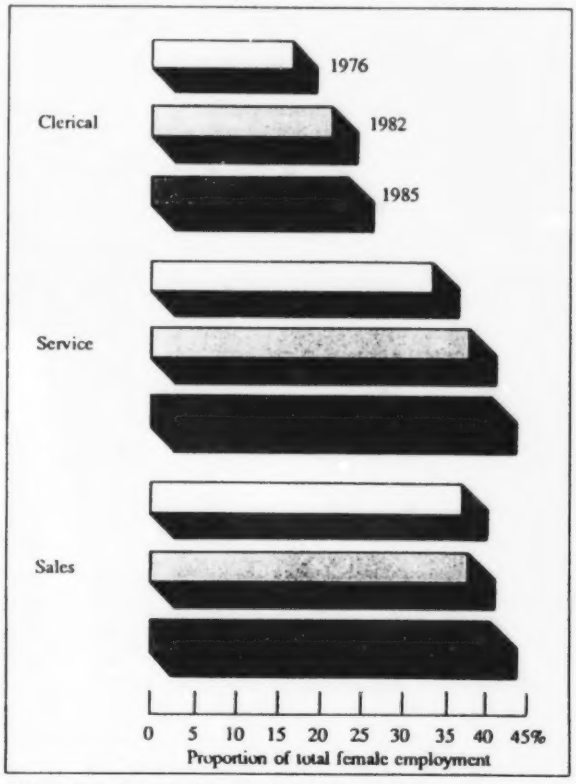
This trend is illustrated by the increase in involuntary part-time work in clerical, service, and sales occupations since 1976 (Figure 23). While the majority of women who are working a shorter week appear to want only part-time jobs, a growing minority would prefer full-time work.

One final cautionary note about the quality of women's jobs is appropriate. Our evidence suggests that the shifting locus of employment opportunities may reduce job quality. As employment opportunities dwindle in manufacturing and in the transportation, communications, and utilities industries (where relatively good pay and working conditions were traditionally found), they have increased in such industries as community, business and personal services, and the finance, insurance, and real estate group, where relatively lower earnings may be more likely and the attachment to the labour force may be less stable and less permanent.

The case studies of women affected by technological change in the federal public service reinforce our emphasis on the instability and impermanence of many female jobs. An important lesson (consistent with our survey findings) is that change can be accommodated without layoffs of *permanent* employees. But "term" and "contract" employees bear the burden of the productivity

Figure 22

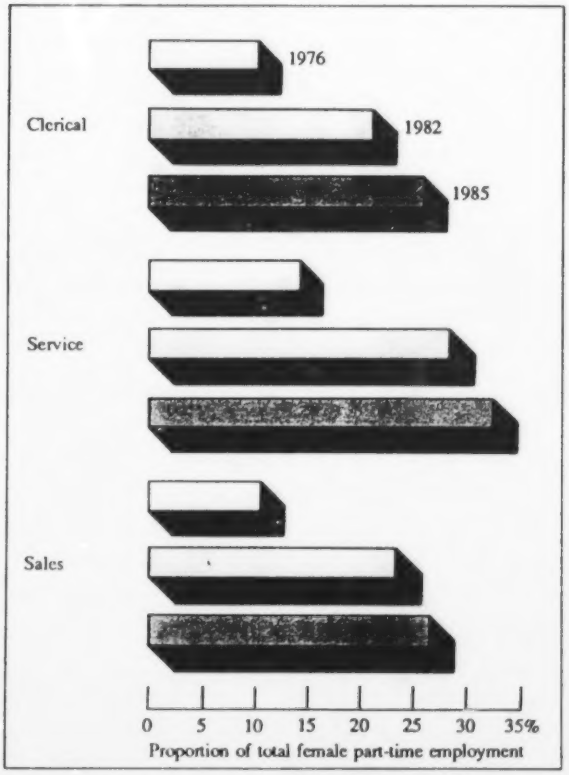
Canadian women in part-time jobs in three occupational groups, 1976, 1982, and 1985



Estimates by the Economic Council based on data from Statistics Canada.

Figure 23

Incidence of "involuntary" part-time work among Canadian women[1] in three occupational groups, 1976, 1982, and 1985



1 The proportion of women in part-time jobs who would prefer to work full-time.

Estimates by the Economic Council based on data from Statistics Canada.

improvement. The case studies also highlight the importance of training and organizational change not only to facilitate acceptance of the new technologies but also to furnish opportunities for personal development.

Other Special Groups

Historically, young people, older workers, native people, and the disabled have experienced disproportionate employment difficulties. Now, there is reason to question whether technological change may exacerbate such problems. It appears likely, for example, that the concentration of native people in a few primary activities (hunting, fishing, trapping, and forestry) and in remote areas may isolate them from the new technologies and the promise they offer. For the disabled, physical access is also a major problem, though medical robotics and imaginative adaptation of personal computers offer some hopes for habilitation into the world of work. For young people, the often bewildering contemplation of career choice is further complicated by a rapidly evolving occupational structure and the accelerating obsolescence of some skills.

This last factor is of particular concern to older workers as well. It is clear that, until we have successfully assimilated the idea that our working lives will necessarily be punctuated by many periods of re-education and retraining, older workers may face severe adjustment problems. Many years out of formal schooling, and brought up in the tradition of a lifetime attachment to a trade or profession, they may find the pace of change disconcerting.

It should be noted, finally, that the numbers of people in these groups are considerable. Young people aged 15 to 24 numbered 4.2 million in 1986 and represented 22 per cent of the labour force. Persons aged 45 to 64 numbered 4.8 million that year and accounted for 24 per cent of the work force. According to the 1981 census, there were over 300,000 native people over the age of 15. And in 1983-84 there were about 2.4 million disabled persons, of whom 14 per cent were classified as having major disabilities.

In characterizing our concerns about the employment problems of all of these groups in an era of rapid technological advance, one common theme is dominant. They all appear to suffer from major inadequacies in educational preparation. Consider Table 2, which shows the percentage of the population in each group that did not graduate from high school. These figures are alarming in themselves. They are much more so when one considers what they mean for these groups' prospects for coping with technological change. Figure 24 vividly illustrates the employment implications of technological change for groups with differing levels of educational attainment. Three such groups are considered: those with less than Grade 9, those with Grade 9 or more but no university education, and those with some university education.

The figure shows the overall ("net") percentage increases in employment experienced by the three groups during the decade 1971-81. It is clear that the higher the level of educational attainment, the greater the percentage increase in jobs. Of special interest, however, are the sources of that net employment growth. Specifically, changes in the input mix of the production process and, more particularly, in labour productivity are combined in the "tech-change effect" in the figure. It is the least-educated group that is the most affected by the negative effects of technological change: the tech-change effect, on

Table 2

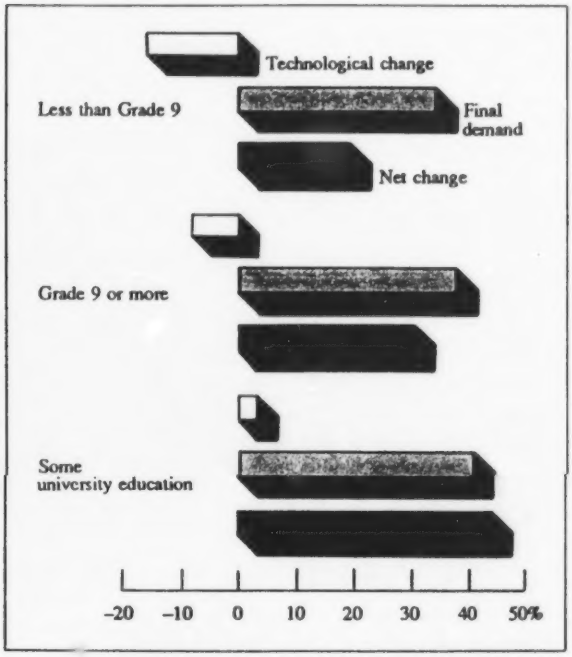
Educational attainment of special groups, Canada, 1981

	Proportion with less than secondary school completion[1]
	(Per cent)
Young people, aged 15 to 19	66.4
Older persons,	
aged 45 to 54	54.4
aged 55 to 64	62.3
Native people	71.3
Disabled persons	high[2]
Total population 15 years and over	47.6

1 Excludes persons presently attending school full-time. About one-third of all 15 to 19 year olds were not attending school in 1981.
2 The number of disabled persons who did not complete secondary school education is not available, but 84.6 per cent have high school graduation or less, and 43.5 per cent completed less than Grade 9.
Estimates by the Economic Council based on data from Statistics Canada.

Figure 24

Impact of changes in technology and final demand on Canadian employment, by educational level of workers, 1971-81



Estimates by the Economic Council based on data from Statistics Canada.

its own, worked in the direction of *reducing* employment for the less-than-Grade-9 group by some 15.4 per cent. (Fortunately, this negative tendency was offset by the positive impact of overall economic activity, labeled "final demand" in the figure.) The negative potential impact of tech-change effects on employment are also apparent, but in significantly smaller proportions, for the group with Grade 9 or more but less than university education. The tech-change effects are actually positive for the group with some university education.

* * * * *

A recurrent theme in all aspects of our work on employment and new technologies is the crucial importance of education and training. Our research on women suggests that, while they have made considerable strides, they are still significantly under-represented in enrolment for certain disciplines – such as engineering and the sciences – that will figure prominently in technological advance.

Education was also identified as a key factor in the ability of other special groups to benefit from technological development. The policy implications are clear but challenging. If young people are ill-prepared educationally, they could well be among the victims of the new technologies.

The challenge is to ensure that special groups will not bear a disproportionate burden in the transition process. A key element is education. For the substantial portion of the working-age population with educational deficiencies who are beyond the normal schooling years, imaginative remedial programs of literacy, educational leave, and private and public vocational training are needed to equip people for the technological challenge.

7 A Strategy for a High-Tech World

Our principal conclusion is that, *together*, the rapid adoption of the new technologies and the development of human resources can bring economic progress and more and better jobs. At the moment, however, Canadians must face up to some uncomfortable facts:

- Canada's industry continues to lag behind that of other countries in adopting the new technologies that are essential to its future prosperity. Thus Canadians have a lot of catching up to do.

- Technological change is never smooth and balanced; it creates both winners and losers, and Canada must do a better job of helping the losers to cope.

• The pace of change in the global economy will remain rapid, and it may even accelerate; so the next round of innovation will have more profound employment consequences than previously.

Objectives and Goals

In our view, Canada lacks the explicit national commitment to new technologies and the cohesive framework of policies that must accompany such commitment. We will therefore set out in this section a framework that points the way towards jobs and well-being for all in a technologically advanced society. This framework rests on "twin pillars." The *first* is rapid adoption of the new technologies. In our view, Canadians have no choice: it is a matter of survival. If Canada does not use the new technologies, its trading rivals will; and jobs will be lost as a result. The *second* facet of this new orientation is a cohesive program of labour market adjustment to develop a well-trained labour force that can fully, rapidly, and fairly exploit the potential benefits of technological change.

These "twin pillars" are clearly mutually supportive: programs that prepare people for the challenges of change and that lessen the pain of transition will enhance the acceptability of the new technologies and hasten their adoption. In short, an innovative economy and adjustment support go hand in hand: one cannot exist without the other.

To give substance to this framework, we advance five related policy objectives:

1 In order to increase productivity, competitiveness, incomes, and employment, all Canadians must openly embrace the new technologies. There is no alternative: failure to do so would entail a loss of prosperity and jobs.

2 The new technologies are vitally necessary, but, alone, they are not sufficient to generate the improvements we seek. A well-trained, flexible, and committed work force is equally important.

3 Technological change is uneven and disruptive. An adjustment policy is required to ensure that its costs are minimized and its benefits are shared.

4 For technological change to be successful, Canadians must innovate on two fronts. Success depends as much on innovations in organization and the development of human resources as it does on technical expertise.

5 If Canadians are to enjoy the fruits of technological progress in a fiercely competitive world, a more constructive industrial-relations climate is essential.

These objectives flow from the "twin pillars"; they are, in turn, the means to achieve the ultimate goal of increased productivity, competitiveness, incomes, and jobs. Together, these elements make up our strategic policy framework. In constructing it, we were guided by the following principles:

• We expect that, in general, decisions with respect to the choice of technologies, of training arrangements, and of adjustment mechanisms will come from the market, with employees and employers identifying their own needs and working out their own solutions.

• At the same time, however, governments will have a very important role to play in establishing the climate within which change must take place.

• Governments should continue to finance training and other adjustment policies; for the most part, however, we advocate a reallocation of expenditures rather than large amounts of new funding. The focus must shift towards a more positive adjustment strategy.

• Adjustment programs must be flexible enough to meet the varying needs of individuals, whether their displacement stems from technological change or from other causes.

• Finally, all segments of Canadian society share a strong interest in the prosperity and jobs that technological change can bring; this commonality of interest should be recognized and enhanced.

In the following pages, we consider specific measures to support each of the five policy objectives in turn.

Rapid Technological Advance

Objective 1:

In order to increase productivity, competitiveness, incomes, and employment, all Canadians must openly embrace the new technologies. There is no alternative: failure to do so would entail a loss of prosperity and jobs.

What is needed is nothing less than a major shift in attitudes and an upgrading of the status given to issues of technological change. Our research clearly shows that technological change brings with it the opportunity for growth in productivity, incomes, and employment. Canada's economy is very open to international trade, but

this country is lagging seriously in the introduction of new technologies. Unless Canada closes the gap, the fruits of technological change will be enjoyed outside its borders. This means that while industrial adjustment will still take place in Canada, it will be in response to failure, not to success. A national commitment to technological change is therefore vital.

The appropriateness of a science and technology policy for Canada has been the subject of national debate for some time now. And in fact, more progress has been made in the 1980s than in all of the three preceding decades. Positive signs include the formation of the National Advisory Board on Science and Technology, chaired by the Prime Minister; of the House of Commons Standing Committee on Research, Science, and Technology; and of the Council of Science and Technology Ministers, a joint federal-provincial body. The mere existence of these bodies is not enough, however; it is the follow-through that is all-important.

Another positive sign is the progress being made in the private sector towards the achievement of a consensus on the important elements of a science and technology policy. This includes, for example, policy statements made by the Canadian Advanced Technology Association and the Canadian Manufacturers' Association. An important principle underlying these statements is the acknowledgment that R&D alone, though necessary, is not enough; other key elements include the rapid adoption and diffusion of technological change throughout Canada, as well as attention to the labour market repercussions of, and adjustment to, technological change.

Raise the Profile of Science and Technology

The potential momentum offered by such steps must be reinforced now by governments, at both the federal and provincial levels. First and foremost, the federal government must play a leadership role by raising the status of science and technology both in Parliament and in the cabinet, and in policy decisions throughout the federal public service. This means that the status of the Minister of State for Science and Technology must be raised to that of senior cabinet minister. Provincial governments also have an important leadership role to play. They, too, can raise the profile of science and technology issues within their own jurisdictions.

Knowledge of, and pride in, Canadian achievements are an important part of a commitment to technological change, and it is here that the media play a key role in national consciousness-raising. Science features, news of Canadian successes, and details of private- and public-sector activities in science and technology can all contribute towards the goal of raising the profile of technology issues.

Improve Technology Information

There is also room for improvement with regard to some existing activities. To provide the information on, and assistance in, the implementation of technological change that is often required, governments – federal and provincial – have established a number of high-tech and innovation centres in recent years. The result, however, is that currently businesses are faced with a bewildering array of centres focusing on a variety of technologies. Some of these centres are federal, and many are provincial; some are university-based, and others are independent organizations. And still others have been created by industry. The sheer number and variety of high-tech centres discourages some potential clients from even attempting to find which one is most appropriate for their needs.

Furthermore, while some of these centres, known as "incubation" or "innovation" centres, provide a full range of services from market research and technological assessment to assistance in the formation of a business, others focus only on the narrower, more technical aspects of innovation. Often, guidance on the "softer" side of technological change – including human resource planning – is lacking. We see two ways, therefore, in which the present system of high-tech centres can be improved.

First, a mechanism for coordinating access to the network of technology and innovation centres needs to be put into place. This mechanism would, in a sense, act as a directory, aiding businesses and those wishing to start a business in identifying which centre or combination of centres is most appropriate for the needs at hand. Here, as with other initiatives proposed in this Statement, we are not suggesting that new funds be made available but rather that existing budgetary allocations be used more effectively.

Second, the expertise of all centres should be rounded out to include not just the purely technical aspects of technological change, but the human resource planning and management aspects as well. The recognition that successful technological change consists of a package made up of technical and human resource planning and management is an important lesson that we have distilled from our research.

Enrich the Technology Debate

Finally, in order to use technological change most effectively for continued growth in living standards, there

is a need for information on an ongoing basis about the rate and direction of change and about the nature of its impact. Research centres with this function exist in a number of European countries, but, to date, there has been no overall focus for issues of this nature in Canada. Concern for fiscal restraint probably means that the establishment of a new centre devoted to research on the social and labour market impacts of technological change, on labour market adjustment, and on organizational design is not feasible at this time. But much more could be done within the existing institutional arrangements.

The importance of technological change for Canada's economic future is apparent. It is highly desirable, for example, that the major economic partners in this country reach a mutual understanding about the need for rapid technological advance and the fair and efficient handling of its benefits and its costs. Much of this must be achieved with patience and good sense in the workplace. But much could be done at higher levels of representation to raise the awareness and understanding of technological change issues and to codify "best practice" in this area. We are persuaded by the examples of collaboration in sectoral task forces, the Major Projects Task Force, and the Canadian Steel Trade Conference, which show that employer and labour representatives can work impressively together on major issues of mutual concern. Many observers had hoped that the Canadian Labour Market and Productivity Centre would be a showcase of such collaboration. We believe its exciting potential might yet be realized if it were focused on a single, urgent, and vital national issue, such as technological change.

Through research and the dissemination of information, and particularly through workshops, conferences, public forums, and demonstration projects, employers and labour representatives could do much to inform their constituencies – and each other – of relevant Canadian and foreign experience, of the lessons to be learned, and of the essential ingredients of "best practice."

A Flexible and Well-Trained Work Force

Objective 2:

The new technologies are vitally necessary, but, alone, they are not sufficient to generate the improvements we seek. A well-trained, flexible, and committed work force is equally important.

A skilled and adaptable labour force is essential on two counts. First, it is a necessary condition for achieving the gains in productivity and competitiveness that potentially reside in advanced technologies. Second, people with the tools to adapt to the new environment will find it easier to make the necessary adjustments. Hence, rapid adoption of new technologies, and successful adjustment to them, depend heavily on the quality of Canada's labour force. That, in turn, depends on the quality of the education system in general and of skills training.

Learning to Learn

Education is a cornerstone. Its importance in a high-technology world cannot be ignored because the accelerating pace of change will lead to rapid obsolescence of skills. The education system therefore faces a profound challenge. It must prepare individuals to be mobile, flexible, adaptable, and versatile.

The ability to learn will be the premium skill of the future. The traditional sequence of formal schooling, on-the-job training, and lifetime practice of one's trade or profession is already being superseded by a more cyclical pattern in which periods of reschooling and retraining feature prominently.

Deficiencies in basic literacy that must be corrected before such "retooling" can occur are an urgent problem for many individuals. So are the appalling inadequacies in educational attainment for special groups in Canadian society – inadequacies that severely hinder the ability of these groups to cope with technological change, as our research shows.

Technological change compounds the urgency of this literacy problem. People with low levels of education have always had poor wages and a high incidence of unemployment. Now, their situation is worsening, at least partly because of technological innovation. The impact of technological change on employment is strongly related to educational attainment. In comparison with other groups, Canadians with less-than-Grade-9 education – often considered the literacy boundary – have experienced serious job losses as a result of the introduction of new technologies. Yet, Canada still has shockingly high rates of high school dropouts.

A two-pronged attack is necessary. First, school retention rates and average educational attainment levels must be raised if the employment and income prospects of future generations of workers are to be improved. Second, for many adult workers, imaginative remedial-education programs and vocational training are required.

More Skills Investment in Industry

In the computer age, the economic performance of firms depends, more than ever, on a well-trained work force. Canadian companies must recognize that training is not a cost but an investment. While many establishments in this country do carry out some retraining when introducing technological change, much of this activity is unstructured and of short duration. It is quite possible that Canadian employers, as a whole, are underestimating the skills required by the new technologies and are underinvesting in training as a result.

For many years, the federal government has offered some support for company training through wage subsidies and the reimbursement of instructional costs. The national industrial training programs do not, however, appear to be making a significant contribution towards encouraging the employer-sponsored training that we believe the new technologies demand. In fact, only one in eight technology-related training programs reported by respondents to the WWTS received any financial assistance from government.

Yet if Canada is to have the human resources that can make the new technologies work, public policy must encourage appropriate levels and types of vocational development within industry. Government support for industrial training must be more accurately focused. Several studies have concluded that, in the past, much of the publicly funded training effort has been directed at occupations with a surplus of workers; for the most part, these are not the occupations that require training for technological change. Only when programs are explicitly directed at specific high-level skills that are clearly in demand do they respond to the direct needs of employers in the area of technology-induced training. In upcoming years, technological change will increase pressures for selected highly skilled occupations; in our view, support for employer-based training in these areas should be an explicit priority for the federal government's training strategy.

Facilitate Continuous Learning

A major thrust of public policy should be directed towards individuals. We have emphasized that technological advance leads to the obsolescence of skills and thus renders "one-career" work lives increasingly uncommon. More and more Canadians must be willing to retrain and reschool at various times: "continuous learning" has become more than a buzzword. Not only is technological change heightening the imperative for skills development by eliminating old jobs and creating new ones, but it is also reducing the employment available for those without advanced skill levels. Canadians need to have an institutional framework that will give them the opportunity to get the retraining and reschooling that they require in order to make the inevitable employment transitions throughout their working lives.

In our opinion, the direction for public policy in the training field should be to provide an "enabling" context – i.e., an environment within which employers and workers can make informed decisions about necessary retooling and can then carry out the required training. The Council does not recommend significant increases in public training expenditures; however, we believe that some reallocation of existing training funds could pay big dividends in the future. The central principles in a retraining policy framework should be:

- private initiative in making training choices;
- support for joint employer-employee solutions;
- concern for those disadvantaged in the labour force;
- flexibility in program design and administration;
- decentralized decision-making.

In such a framework, the role of governments should be twofold: first, to provide funding arrangements aimed at facilitating the achievement of the goals; and, second, to ensure the availability of accurate information on the labour market.

There are some interesting recent initiatives in various provincial jurisdictions that recognize some of these principles. Important developments have occurred at the federal level as well. A primary focus of the Canadian Jobs Strategy, introduced in 1985, is on those who have an employment disadvantage. In addition, the CJS administrative framework appears to emphasize flexibility, at least to the extent possible within such a massive program. In principle, the initiatives that receive funding are to be determined, not in Ottawa, but at the regional (and even local) level.

Providing Funds and Leave for Training

One of the six Canadian Jobs Strategy components that has attracted our attention is the Skill Investment program. Compared with the other elements of the CJS package, this component has a relatively low profile and budget. It focuses on retraining workers in positions threatened by change and includes options that, in our view, support the kinds of skills development arrange-

ments that are called for in a high-technology labour market.

One such option is the training trust fund, in which the federal government will match employee and employer contributions to build a fund for future training. Disbursements from the fund are authorized by a labour-management board of trustees. Another Skill Investment option is the extended training leave. Here, the employer and a worker whose job is threatened agree to full-time leave so that the employee may pursue vocational development, with the federal government and the employer both contributing to his/her salary.

These approaches facilitate continuous learning through innovative arrangements. To this point, however, neither the trust-fund option nor the extended-training-leave option has had a high "take-up" rate, although there are some good examples of training funds operating in the construction industry.* We are concerned that this reflects inadequate commitment on the part of Canadian industry to invest in the skills of its workers. We believe that programs along the lines of the trust-fund and extended-leave options hold considerable promise for strengthening Canada's industrial training effort. Accordingly, the federal government should seriously consider ways of tailoring these kinds of approaches in order to increase their attractiveness to the private sector.

The Council has supported the concept of vocational leave before. In our last major report on the labour market, *In Short Supply*, we recommended that Canada ratify, and consider the means of implementing, the convention adopted by the International Labour Organization in 1974, which recommends that every member country formulate and apply a policy for the promotion of paid educational leave. This has not yet occurred in this country, although the importance of lifelong vocational development continues to grow. We would therefore like to focus attention once again on the feasibility of implementing a paid-educational-leave policy in Canada. Naturally, the administration of such a policy – and, especially, the question of who will pay for it – is a contentious issue. We suggest a shared responsibility among workers, employers, and governments. All will benefit from a society where reschooling and retraining are accessible.

While supporting the widespread application of skills-development-leave arrangements, we are not unfamiliar with their limitations. In particular, they are generally useful only to employed, and often long-employed, individuals. Yet it is people without jobs who, above all, need these opportunities. There has been some recent discussion – by the Skill Development Leave Task Force, for example – of voucher schemes to support retraining or reschooling. We believe these could play an effective role in helping Canadians to adjust to technological and other changes.

There are precedents for voucher-style programs in this country. Most recently, in the early 1980s, portable wage subsidies were offered under the Industrial and Labour Adjustment Program for laid-off older workers in designated industries and communities. This subsidy took the form of a voucher given to the individual, who could offer it to a prospective employer. Our proposal is to use similar vouchers to cover the costs of legitimate employer-sponsored training. They could also be used as tuition for programs at education or training institutions. In addition to enabling the older workers to pursue continuous learning, this approach would encourage institutions to respond to market demands. Much of the funding for a voucher plan could be taken from existing training programs. The major departure of this approach is not in the expenditure levels that would be required but, rather, in the source of the initiative for training.

The underlying idea is that workers could spend their vouchers in ways that they determined as most appropriate for developing the desired vocational skills. In countries where such systems exist, the worth of the vouchers tends to be based on the worker's age or on the length of his/her attachment to the labour force. While this increases their usefulness as an adjustment tool for older workers, it does not do so for young people and, in many cases, women. Entitlement details would therefore require considerable attention.

Improve Forecasting

Accurate and timely information is essential if suggestions along these lines are to be of maximum use. The need for *prospective* information is particularly critical because many costly education and training decisions must be taken months and years in advance. We wish to emphasize that the importance of information is further magnified by technological change and, in particular, by its rapidity.

In this light, we must draw attention to the need for greater emphasis on labour market forecasting in this country. The Canadian Occupational Projection System (COPS), which we used in Chapter 4 of our research

*Funds in the construction industry tend to be operated jointly by unions and employers' associations. Two Ontario examples are the International Union of Operating Engineers Local 793 Training Fund and the Labourers' International Union Local 183 Training and Rehabilitation Fund.

report, is an ambitious attempt to involve a variety of users of labour market information and to draw on various sources of data to provide detailed occupational projections. Despite concerted efforts to augment the system by means of special studies and analytical refinements, however, it is still unable to incorporate systematically the effects of technological change. We therefore urge Employment and Immigration Canada to assign high priority to correcting this deficiency, drawing on the innovative work done with the Microelectronic Simulation Model (MESIM), also used in Chapter 4 of our research document.

Efficient and Equitable Adjustment Assistance

Objective 3:

Technological change is uneven and disruptive. An adjustment policy is required to ensure that its costs are minimized and its benefits are shared.

In a rapidly changing economy, it is essential that individuals be able to adjust to shifting circumstances. We have stressed that a flexible and appropriately skilled work force contributes to both efficiency and equity objectives. Indeed, the proposals put forward in the preceding paragraphs are designed to stimulate the formation of such a labour force by encouraging continuing skills development in those areas in demand. The intent of those proposals is to create an institutional framework in which individual adjustment to change becomes an ongoing process.

We emphasize individual adjustment because, realistically, some displacement will inevitably occur during the process of change. Studies of displaced workers show that, in human terms, the word "adjustment" may encompass such hardships as reductions in family income, deteriorating health, neighbourhood and community decline, loss of self-confidence, depression, marital strife, and drug and alcohol abuse. And the longer a spell of joblessness persists, the lower are the chances of successful re-employment. We firmly believe, therefore, that a variety of means must be explored at various levels if the pain of transition is to be minimized.

Easing the Transition

At the level of the individual firm, for instance, we are impressed by the examples of North American companies that have made genuine efforts to "close the door gently." In anticipation of closure and layoffs, some firms, in addition to severance pay, have offered assessment and testing, as well as remedial-education and retraining programs. Many have offered counselling on job availability, interviewing skills, and résumé writing, as well as advice on making the transition to a new employer. Some have set up local employment committees in conjunction with a union and with government placement agencies, while others have undertaken sizeable advertising campaigns to alert other area employers to the availability of various skills.

Unions, too, have an important role to play. We note the example of Local 1005 of the United Steelworkers in Hamilton, which has initiated a unique assessment and retraining program for laid-off members, using facilities in its refitted union hall as well as the services of Mohawk College.

Such initiatives are necessary and laudable. In many cases, however, there will be severe limits on how much individuals, firms, and unions can accomplish. A broader, public framework of adjustment assistance is therefore necessary.

The Industrial Adjustment Service

The federal government's labour market policy package includes the Industrial Adjustment Service, which bears particular relevance to this issue. The objective of the IAS is to encourage management and labour to work together towards an effective adjustment of the labour force to economic or technological change. The program typically operates at the establishment level through a bilateral committee, which oversees the development and implementation of solutions to the particular adjustment problems involved. Such problems might include layoffs, technological change, plant expansion, high turnover, or sagging productivity, to name just a few examples. In addition to facilitating the negotiation of an adjustment agreement and the establishment of the committee, the IAS plays a consultative role in the adjustment process, particularly with respect to the use of available labour market programs. It also funds a portion of the committee's expenses. While the government is the facilitator, however, it is the parties themselves who must work out a solution.

The Industrial Adjustment Service has received good marks from various policy reviews and, indeed, has developed a favourable reputation outside this country. A number of American states have examined the program closely, with an eye to adopting it themselves. The IAS has had a positive impact on easing labour market

adjustment problems and has fostered labour-management cooperation. It has proven to be a fast, flexible, and cost-effective method of promoting adjustment. There have been suggestions that the IAS would be even more useful if, in some instances, it could get involved in the adjustment process earlier, before layoffs are inevitable. The service, however, is a voluntary one: typically, it is invoked in response to a request from the parties involved. While the IAS does try to make its availability known in situations where there is likely to be a need for its services, resource constraints limit this sort of anticipative marketing.

In our view, there is a substantial and growing market for the adjustment support offered by the IAS. Yet it remains a small program, with annual expenditures of less than $10 million. Therefore, we suggest that the Industrial Adjustment Service be expanded through a gradual increase in its financial and personnel resources.

Part-Time Workers

An important rationale for labour adjustment policy is that the costs of transition are not evenly distributed. Certain groups typically experience relatively unfavourable employment outcomes, and our research suggests that their adaptation to change may be particularly difficult. We have seen some evidence of this for those Canadians with low levels of educational attainment. Older workers, as well, clearly face specific threats due to change. We have also voiced concerns, for example, over the emerging job structure for females. In our view, a national approach to innovation and employment must focus special consideration on those individuals and groups who may be assuming disproportionate transition costs.

One focus of our investigation has involved the relationship between technological innovation and part-time employment. While the new technologies can facilitate flexible alternative arrangements that may be desirable in some cases, at the same time they may well be contributing to involuntary part-time work. Currently, those people who are working part-time – many of whom are women or older workers, or among the young or the disabled – are penalized by not sharing proportionately in the benefits and protection available to full-time employees. This concern applies both to statutory programs, such as unemployment insurance, and to private benefits – most notably private pension-plan coverage. We recognize, however, that the question is complex. For example, some part-time workers place primary importance on immediate cash flow rather than on long-run considerations. And employers, for their part, view such provisions as a source of increased labour costs. In view of the sheer magnitude of part-time work, however, it is clear that the time has come to face this issue.

The Disabled

A final area of specific concern is the situation of disabled persons. Technological change offers tremendous opportunities for advances in the quality of life of disabled persons, in part because of the relaxation of physical job requirements. However, the opening-up of a vast array of working opportunities for the handicapped can be achieved only if employers themselves are informed about how they can cope with special needs. The solutions are often simple and inexpensive, but they are not always obvious to those who have had little experience in dealing with such needs. A central source of expertise and information for companies on how to deal with practical problems involving the disabled could make a very positive contribution towards reducing a gap that is born of lack of awareness and understanding. An interesting example of such an agency is found in the United States in the Job Accommodation Network (JAN). Through a toll-free number, information is provided on often very simple solutions to seemingly complex problems. A similar agency in Canada could supply information on technical aids and architectural modifications; it could provide to prospective clients real-world examples of similar situations and of the solutions developed; and it could recommend types of equipment and sources of supply.

Innovative Management

Objective 4:

For technological change to be successful, Canadians must innovate on two fronts. Success depends as much on innovations in organization and the development of human resources as it does on technical expertise.

Canadian management must become more creative in applying technology, in deploying human resources, and in combining technical and human resources. To be truly effective, the new technologies must be managed as an integrated system, made up of both innovative machinery and equipment, and of highly skilled workers.

Innovate on Two Fronts

The educational system has a crucial role to play, not only in the shaping of a labour force that is capable of, and comfortable with, working with the new technol-

ogies, but also in producing the managers, scientists, and technicians who play a central role in developing and introducing these technologies. The effective management of technological change has several facets. First, managers must be aware of the capabilities of the new technologies, of the contribution that they can make to their business, and of how best to integrate them with the firm's human capital. Similarly, scientists and engineers who develop technological applications should have an awareness and understanding of the links between technological change and current business needs, and of how technical resources can best be integrated with human resources. In other words, the most successful businesses will be those which have managers with some technical understanding, and scientific and technical staff with some sense of business management. All will have an appreciation for the relationship between human resources and technological change.

Too often, however, the bridges between these skills are conspicuously absent. Steps should be taken, therefore, by Canada's engineering and business schools to produce more fully rounded graduates. We are aware that workloads are already heavy. Interdisciplinary skills, however, are not a luxury: they are a necessity.

Closer Business-Education Ties

Also in need of strengthening are the links between business and the advanced education community. While some steps have been taken in recent years to reduce the gap between those two groups, it remains wide, for the most part. The environment within which the educational system operates has changed a great deal. Demands are being made for a system that is more attuned to the immediate requirements of industry for marketable technology and for specifically trained, but nevertheless flexible, labour market participants. Often, however, there is a very real lack of appreciation for the very different environments within which the business and academic communities operate. On the one hand, business tends to have a very short-term, goal-specific outlook, while the educational system – and universities, in particular – traditionally has had a longer-term outlook and a learning rather than a skills orientation.

Cooperative Education and Exchanges

At the same time, both groups could benefit from a closer relationship. This could be accomplished in several ways. For example, we applaud the steps that have been taken in recent years to reduce the insular character of much professional training. Through meetings and discussions, university-industry cooperation on the identification of needs and solutions is being fostered. One group in particular – the Corporate-Higher Education Forum – has been working to promote improved communication between these two communities with respect to professional training and other issues of joint concern.

Another example is that of cooperative educational programs, wherein students alternate periods of schooling with periods of working in their fields. Business benefits by having a relatively inexpensive source of skilled labour; students benefit from the opportunity to apply and modify knowledge gained in an academic environment; and universities benefit from the feedback provided by students who have been exposed to the business world. There is no reason why such a beneficial exchange could not take place at more senior levels as well. Members of both the business and academic communities would gain a deeper appreciation of the environments in which the other works, and both would benefit from having access to the other's skills. For a system of exchange to work, however, participants should not see their career prospects threatened because they remove themselves to another environment for a period of time.

To a certain extent, such exchanges do take place already. But the system is highly dependent upon those rare individuals who successfully combine an enthusiasm for both the academic and business worlds with the flexibility to move comfortably between the two. The growing trend towards the formation of groups of business people to advise on academic programs is a step in the right direction. That step should be taken further to the stage of involvement in the learning and teaching experiences directly.

Strategic Partnering

More use should also be made of other types of cooperative arrangements. For some types of research and technology development, for example, the scale of activity required is very large, surpassing the capabilities of any one group. In such cases, research consortia present an effective alternative. Similarly, joint identification of training needs and capabilities would help businesses and educational institutions to allocate their resources more efficiently and effectively. In the fields of research, technology development, and training, innovative arrangements that tap the skills of both business and postsecondary institutions in a mutually supportive way can bring large payoffs.

Industry and employee associations can play a catalytic and coordinating role in the identification of common

industry needs with respect to research and training for the new technologies, and they can act as a go-between, bringing together business, educational institutions, and labour. Community-based efforts that build on local industry and educational strengths can also work towards the same goal.

Elements of Success

We have already emphasized that the theme of innovative management also includes a focus on "soft" technology. Here, the stress is on the management of people, the interaction of managers and workers, and the organization of work. The following key ingredients of an effective and enlightened management style are distilled from our case studies of individual firms:

- pre-planning of both the social and technical aspects of innovation;
- participation by all those who are involved in, and affected by, the innovation process;
- development of more collaborative and flexible work designs and methods;
- commitment to the existing work force;
- retraining and continuing skills development; and
- management training that imparts an understanding of the organizational and human resource consequences of technological developments.

In earlier sections of this Statement, we made public-policy proposals relating to a number of these important areas – skills development and management training, for example. It is clear, however, that success will ultimately depend on the initiative of Canadian workers and the innovative approaches of managers, as well as governments. Some practices relating to the key principles set out above have impressed us, and we offer the following observations to representatives of Canadian business and labour.

Our organization-level research revealed to us the importance of the planning process itself. Effective innovation begins long before any equipment arrives at the company door. We have noted that advance preparation inevitably pays dividends through technological change that works. But the planning must incorporate both the technical and social aspects of innovation. Too often, planning does not go beyond the engineering department, with the consequence that implications for the roles and responsibilities of the work force are inadequately anticipated. However, we did witness, and were impressed by, some cases where the equipment, the production process, the job design scheme, and hence the human resource and training requirements were considered and worked out well in advance. Ideally, all of those involved should take part in comprehensive planning of this type.

As far as on-the-job training is concerned, our case studies uncovered some highly specific but imaginative approaches (see box). The common thread running through them was a managerial commitment to the existing work force.

Mutually Reliant
Labour-Management Relations

Objective 5:

If Canadians are to enjoy the fruits of technological progress in a fiercely competitive world, a more constructive industrial-relations climate is essential.

Throughout this report, we have emphasized the "people" side of industrial innovation. A critical issue associated with technological change is the labour-management relationship. There is already considerable pressure on employers, workers, and unions to alter traditional patterns of behaviour. In our view, labour and management in this country need to find ways of working together more effectively.

Both employers and workers should recognize their strong common interests. Above all, they share an interest in a healthy economy – one in which competitiveness and fairness stand side by side. We are aware, as well, that on some issues the interests of the parties cannot always coincide. That is a simple reality of the Canadian system. Where this is the case, labour and management must negotiate constructively in order to find mutually acceptable solutions.

The key is involvement. The record shows that workers and unions in Canada are not opposed to technological change itself, but they are uneasy about the way it is introduced. All of those concerned need to participate in decisions affecting their organization. Where this takes place, people know that their concerns will be addressed; as a consequence, they tend to accept and even appreciate technological and organizational change. The participation of workers and their unions is desirable for social reasons, of course, but evidence from other countries indicates that there are "bottom-line" benefits as well. In Japan and Sweden, for example, institutions – quite different in the two countries – accommodate the involvement of all those with a stake in the outcome. Notably, both

Examples of Industrial Training and Retraining Efforts

Company A

Company A was building a state-of-the-art "greenfield" site alongside existing operations that were simultaneously undergoing extensive modernization. The employer and the union had agreed on a staffing approach that gave workers in the existing plants priority for the highly paid jobs in the new one. Moreover, the vacancies created in the process were filled according to an internal bumping procedure. The net result was that virtually all of the employees in the revamped operations required retraining. The systematic planning undertaken to identify such large training needs and to arrange the necessary retraining to meet the production schedule was particularly impressive. The approach used was a "train-the-trainer" method, in which selected operators not only received training in a vocational skill created by the new technology but were also trained to become trainers for that occupation.

Company B

At another plant, efforts have been made to emphasize the ongoing importance of skills development, to raise its visibility, and to improve its accessibility. The importance of training has been underlined by erecting a "learning centre" within the plant. All employees have been allotted a minimum number of training hours per month that can be taken during normal working time, for approved training modules. Such training may involve group instruction in a classroom at the learning centre, individual use of video cassettes, hands-on operation of simulators of new equipment, or familiarization with a computer terminal. Employees also have access to the learning centre on their own time and can borrow from an extensive library of audio and video tapes for use at home.

Company C

In a third company, there is a relatively new development that could complement the kind of facility described in the second example but that, because of its cost effectiveness, has enormous potential for application in education institutions and at home. Known as computer-based training (CBT) or computer-assisted learning (CAL), it involves a "user-friendly," interactive, self-teaching program that can cover almost any subject at almost any level. From simple database management to typing, from basic mathematics to accounting, the insertion of a disc and a few simple keyboard commands enable the trainee at a terminal to learn at a comfortable pace.

From Betcherman and Newton, "A case book."

countries have adopted the new technologies at a pace and on a scale beyond Canada's.

While such foreign experiences are instructive, we recognize the importance of "made-in-Canada" solutions. In this country, collective bargaining has developed as the principal means for regulating the labour-management relationship. Thus approaches for strengthening industrial relations in Canada should start from that collective-bargaining cornerstone.

Improve Collective Bargaining

In this study, we have considered the current arrangements with respect to collective bargaining over technological change in some detail. Certainly, there are some examples in Canada of employers and unions negotiating many aspects of innovation to their mutual benefit. In the final analysis, however, our review suggests that there is not a great deal of collective bargaining on technological change and its impact. And where work contracts do contain clauses linked to technological change, they tend to be weakly enforced. Industrial relations systems are effective when the differing interests of the parties are dealt with to the satisfaction of both. Currently, issues associated with technological change are not meeting that standard. In our view, some positive steps can be taken to strengthen the contribution that collective bargaining can make in resolving technology-related issues.

Four jurisdictions in Canada have enacted statutory provisions aimed at encouraging collective bargaining

over technological change. Until now, with the partial exception of British Columbia, this legislation does not appear to have succeeded in its objective. That the goals have been better realized in British Columbia is, in our view, at least partly the result of differences between the approach in that province and those of the other three jurisdictions.* One important difference in the B.C. model is that, in contrast with the other three relevant cases, there is no opportunity for opting out of the legislation's purview. In the federal jurisdiction, for example, the parties are exempted if they have privately negotiated related clauses or if the contract stipulates that the *Canada Labour Code*'s provisions on technological change do not apply.

There are other ways in which the B.C. legislation departs from that of the other jurisdictions. These include a less restrictive definition of what constitutes technological change as well as a procedure for referring technology-related disputes to binding arbitration. We encourage all Canadian jurisdictions to examine British Columbia's legislative approach as a possible means of promoting genuine and positive bargaining over technology-related issues.

Establish Joint Committees

In addition to strengthening the contribution of collective bargaining, it is also important to consider other industrial relations mechanisms for promoting interaction over technological change and its impact. We have noted that formal bargaining over technology, not only here but elsewhere, tends to be somewhat sporadic and, too often, defensive in nature. Furthermore, we must remember that the majority of Canadian workers are outside the collective bargaining system and, consequently, have no formal structures for making their voices heard. As well, a substantial number of unionized workers in the public sector are barred by legislation from bargaining over technological change.

For these reasons, we have carefully considered arrangements that would complement the formal collective-bargaining approach. A number of earlier investigations, notably the federal government's Task Force on Microelectronics and Employment, have concluded that ongoing interaction over technological change would be encouraged through the institution of establishment-level labour-management committees. We also see such committees as potentially useful mechanisms for bilateral discussion of employment-related issues associated with the introduction of new technologies.

These bodies should have a mandate to deal with employment issues (such as job security, wages, retraining, and health and safety) arising in response to technological change. We must emphasize that our intention in making this suggestion is not to circumvent existing collective-bargaining arrangements. It is very important that, in unionized settings, labour representatives be elected from among active union members. The aim of the committees would be to encourage employers and workers to discuss, and seek solutions to, ongoing innovation-related issues.

In Conclusion...

It is only realistic to report that technological change is a mixed blessing. It will put pressure on labour markets and it will prove costly for many individuals. We have tried, however, to show where its effects are likely to be felt, and we have tried to suggest actions to help alleviate them. At the same time, we have drawn attention to the promise that the new technologies hold out in terms of rising productivity, higher quality, greater competitiveness, and increased employment. We have also shown in this Statement that it is possible to use technology while preserving the sense of fairness and tradition of sharing burdens that are characteristic of Canadians.

Canada needs a national policy framework that will stimulate firms, individuals, and governments to develop the capacity to use the new technologies. In short, we believe that Canadians can make technology work.

*As this document was going to press, the Government of British Columbia proposed certain changes in the provincial labour code. We wish to make it clear that our discussion refers to the provisions that existed in April 1987.

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